NGL-19-001-105
FINAL

AN INVESTIGATION OF ENVIRONMENTAL FACTORS ASSOCIATED WITH THE CURRENT AND PROPOSED JETTY SYSTEMS AT BELLE PASS, LOUISIANA

(NASA-CR-141312) AN INVESTIGATION OF ENVIRONMENTAL FACTORS ASSOCIATED WITH THE CURRENT AND PROPOSED JETTY SYSTEMS AT BELLE PASS, LOUISIANA Final Report (Louisiana State Univ.) 44 p HC $3.75 CSCL 08C G3/48
N75-15253
Unclas
06616

THE DIVISION OF ENGINEERING RESEARCH
LOUISIANA STATE UNIVERSITY
BATON ROUGE, LOUISIANA

NOVEMBER 1974

AN INVESTIGATION OF ENVIRONMENTAL FACTORS ASSOCIATED WITH THE CURRENT AND PROPOSED JETTY SYSTEMS, AT BELLE PASS, LOUISIANA

A FINAL REPORT

TO

The Greater Lafourche Port and Harbor Commission
Golden Meadow, Louisiana

and

The National Aeronautics and Space Administration
Washington, D.C.

by

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November 6, 1974

"The opinions, findings and conclusions expressed in this publication are those of the authors and not necessarily those of the Greater Lafourche Port and Harbor Commission or the National Aeronautics and Space Administration."

This work was sponsored by NASA through Grant No. NGL 19-001-105, by the Lafourche Port and Harbor Commission grant for support of graduate students, 1974, and state funds from the Division of Engineering Research, LSU, Baton Rouge, Louisiana.

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I. INTRODUCTION

The Greater Lafourche Port and Harbor Commission has proposed to improve the existing jetty system and channel at Belle Pass, the outlet of Bayou Lafourche, for better navigational access. This outlet (Figure 1) is regularly and heavily travelled by vessels operated by the petroleum and fishing industries of South Louisiana. It also serves as an emergency entrance to inland ports when rough seas, storms, and hurricanes occur in the Gulf of Mexico.

Belle Pass is presently maintained at a depth of 20 feet and protected by an existing rock jetty on the east side. The proposed improvements consist of a 1000-foot extension to the existing east jetty, removal of the remnant west jetty, and construction of a new west jetty to provide a width of 1200 feet. The channel would also be dredged to a width of 300 feet and a depth of 20 feet into the Gulf to the 20-foot contour (Figure 2).

The Commission had applied to the U.S. Army Corps of Engineers for the necessary permit to make the proposed changes to Belle Pass.

Because jetty systems in many cases cause accelerated erosion of the adjoining shoreline, the Crops of Engineers declined a work permit until the effects of the proposed changes had been studied.

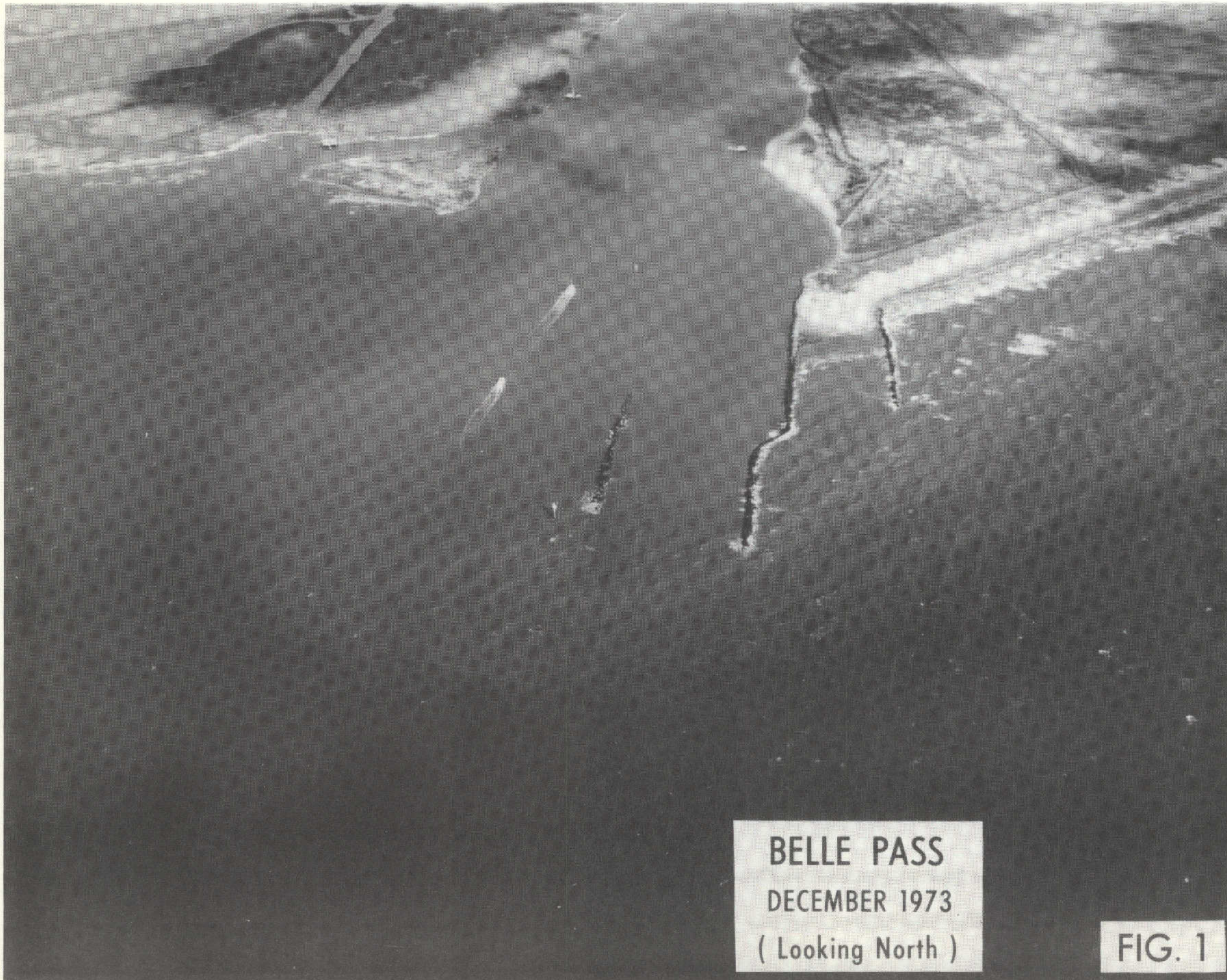
Jetties and groins disrupt littoral currents, the longshore movement of water caused by waves breaking at an angle to the shoreline. Beach materials and suspended sediment from the active surf zone are carried by this current and redeposited on the shore downdrift. An interruption of longshore transport will generally result in accumulation of sand on the updrift side of a jetty or groin and deprivation of the shore downdrift of the structure. The recession rate on the downdrift side is determined by the volume of material moved by the littoral current and the prevailing recession rate of the beaches in the same area.

Thus the specific objectives of this study were to:

(1) Determine the history of the existing jetty system, including its past effect on the littoral currents and beach erosion

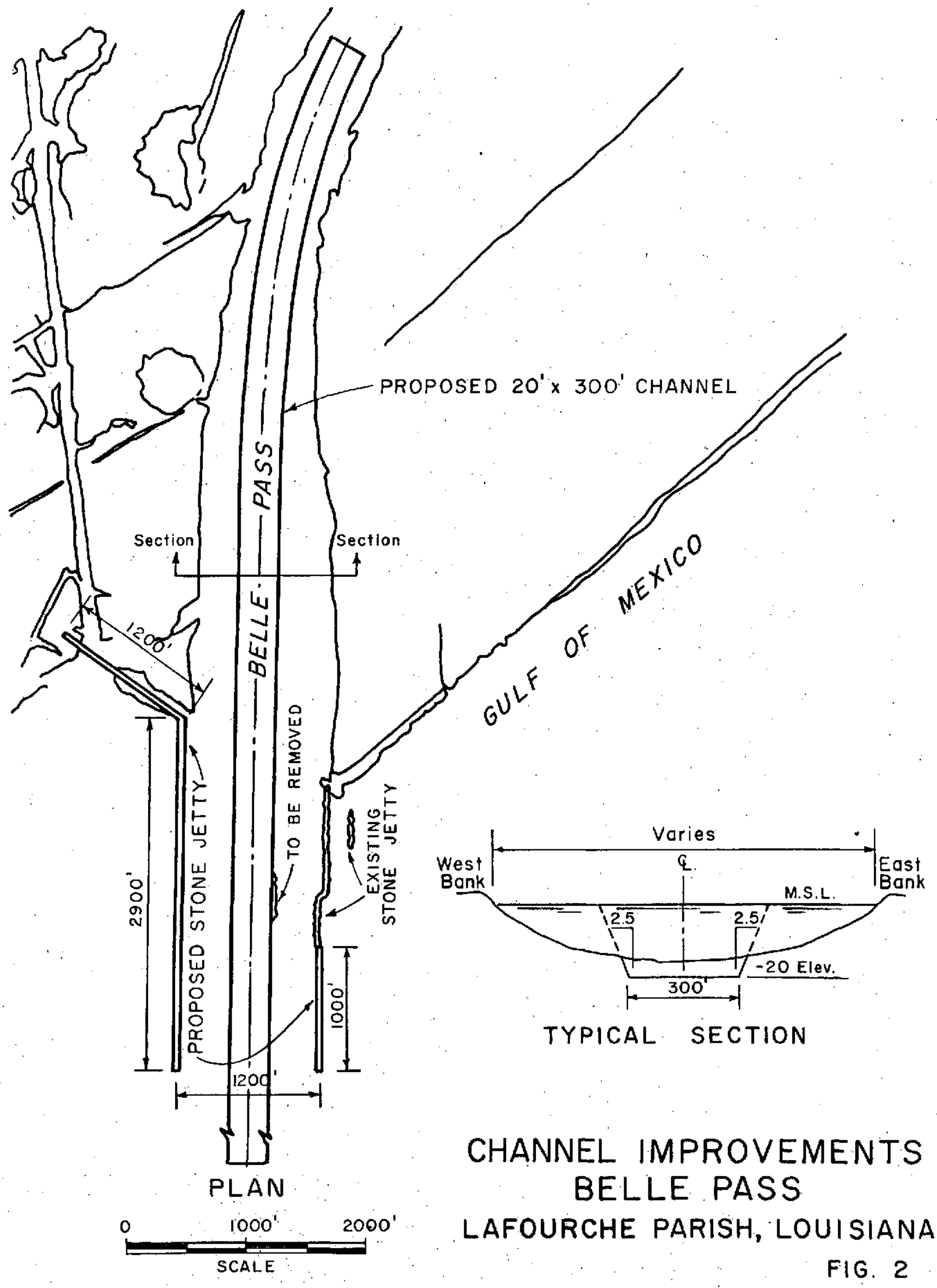
(2) Determine the present flow patterns and erosion rates in the Belle Pass area and the prevailing recession rates of local beaches not under the influence of the existing jetty systems

(3) Offer alternatives to the proposed jetty design that will reduce possible detrimental effects



BELLE PASS
DECEMBER 1973
(Looking North)

FIG. 1



CHANNEL IMPROVEMENTS
BELLE PASS
LAFOURCHE PARISH, LOUISIANA

FIG. 2

II. AERIAL PHOTO AND MAP STUDY

Aerial photographs and maps were used in part of the study of the physical processes in the Belle Pass area. From recent NASA 9 x 9 aerial color photos and older Corps of Engineer photographs, the direction of littoral drift was determined by the orientation of the wave trains approaching the shore and from small visible sediment plumes adjacent to the beach and the pass. The photographs also showed the width of the littoral zone and, to some extent, the volume of sediment being transported.

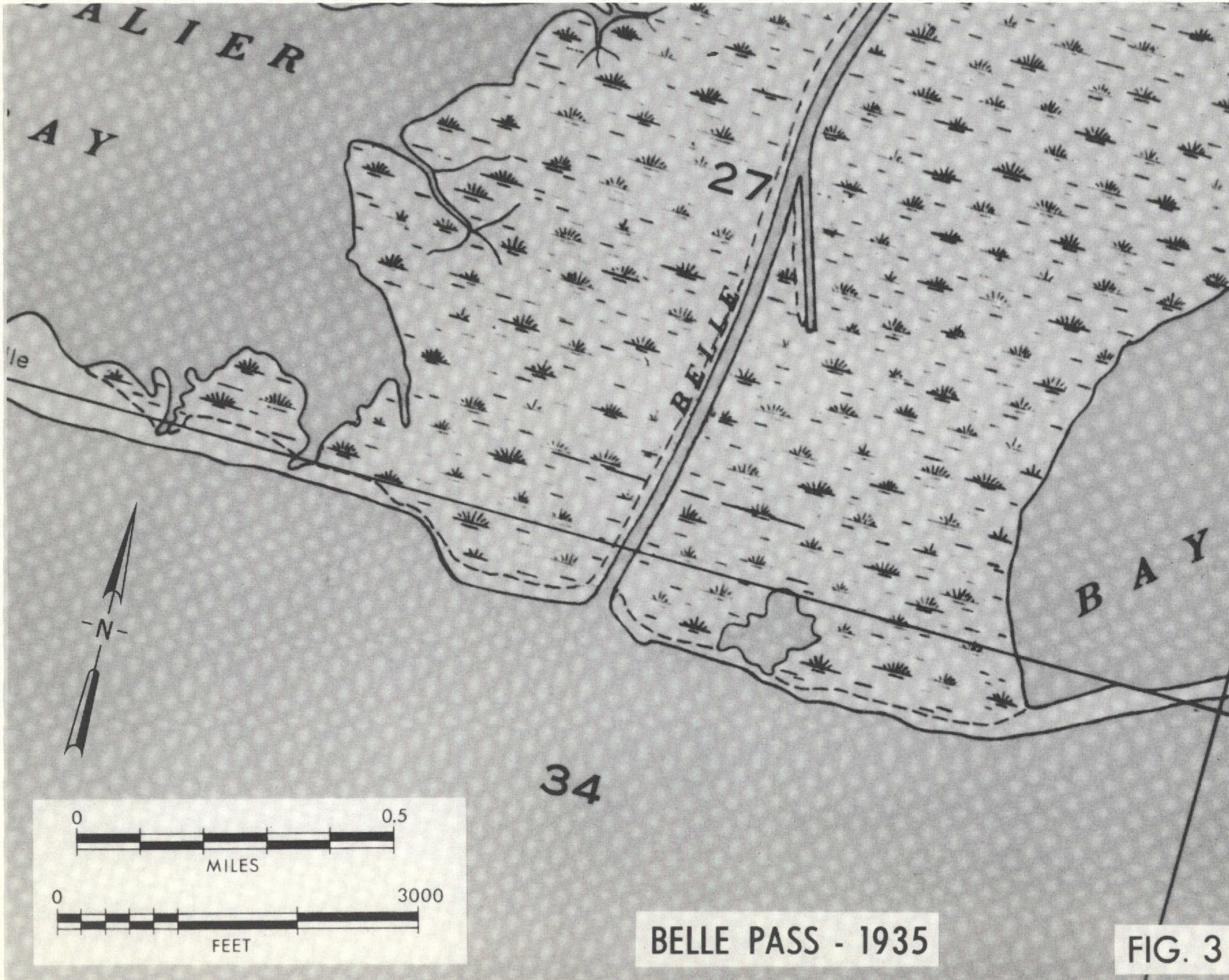
Littoral drift may vary in magnitude and direction as a result of differences in strength and direction of the wave-generating winds. The photographs were used to determine variations in littoral currents and beach configuration. They also demonstrated the effect of ebb tidal flow in the bayou that also deflects the littoral flow. Because Bayou Lafourche water is characteristically more turbid and less saline than the gulf water and does not readily mix, its entrance into the gulf was easily detected on the aerial photographs, particularly in color and infrared color. Aerial photographs, along with older maps, were used to help establish the history of the existing jetty system.

Figures 3 through 8, photographically sized to the same scale, comprise a pictorial history of the Belle Pass area. Figure 3 (1935) shows the pass before the installation of the jetties; Figure 4 (1945) shows the jetties after shore-end extensions; Figure 5 (1953) shows the area after 8 years of beach recession; Figure 6 (1956) shows the pass after the Corps of Engineers dredged a new channel west of the old jetty system and an oil company dredged a canal parallel to the west beach; Figure 7 (1972) and Figure 8 (1973) show the most recent changes.

It is evident from the photographs that the beaches east and west of the jetty have steadily receded. Later in this section, it will be shown that recession was occurring before the installation of the jetties and has since occurred at varying rates, except for the areas immediately adjacent to the channel on the west where the erosion has apparently been retarded.

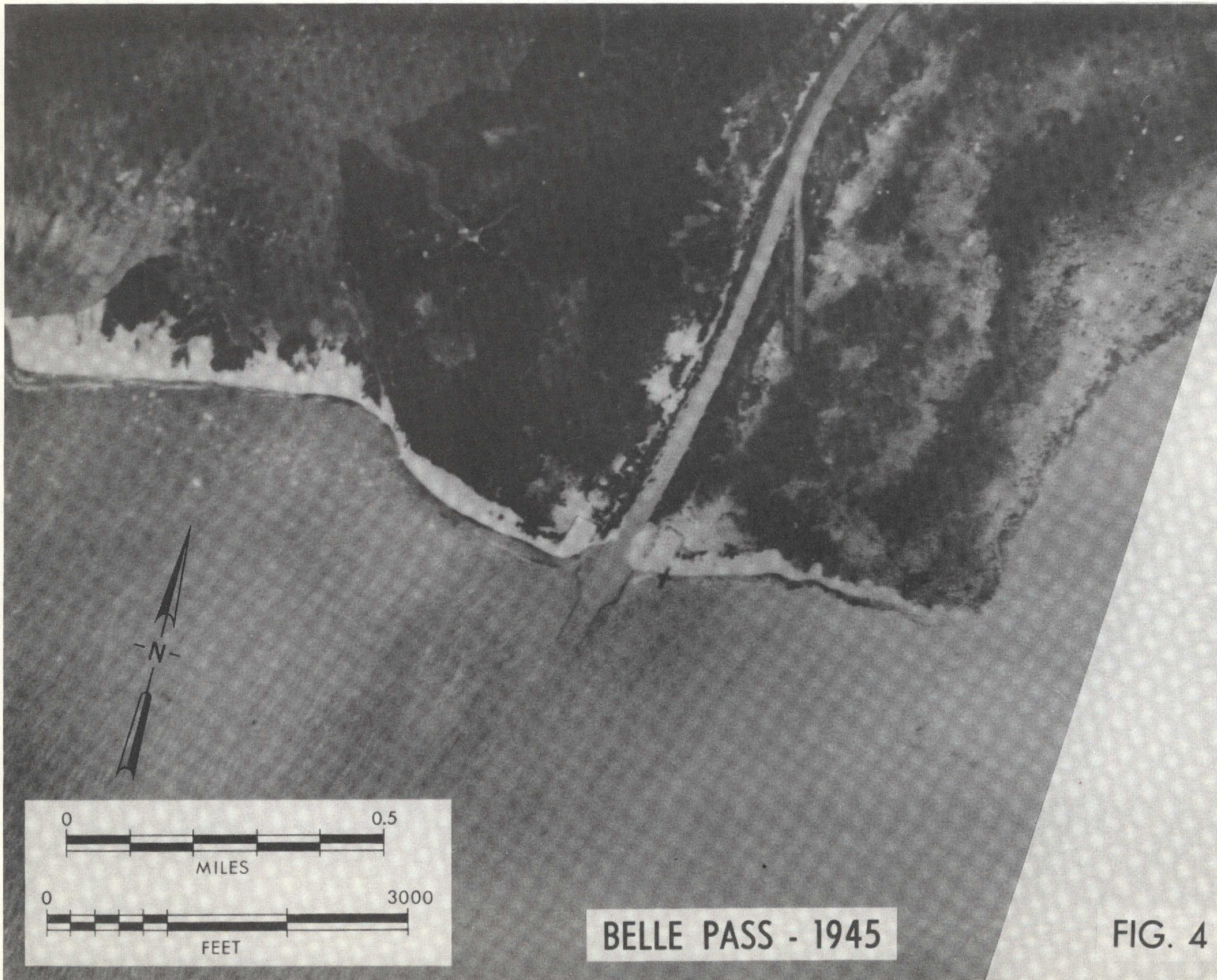
Line tracings from the maps and photographs for 1935, 1945, 1953, 1969, and September 1973 were drawn to comprise an overlay sequence covering this history of the jetty. This sequence was then graphically combined (Figure 9A).

The classical effects of a groin or jetty installation are accretion on the updrift side and recession on the downdrift side. However, accretion has not occurred at Belle Pass. Apparently the recession rate has been lessened directly



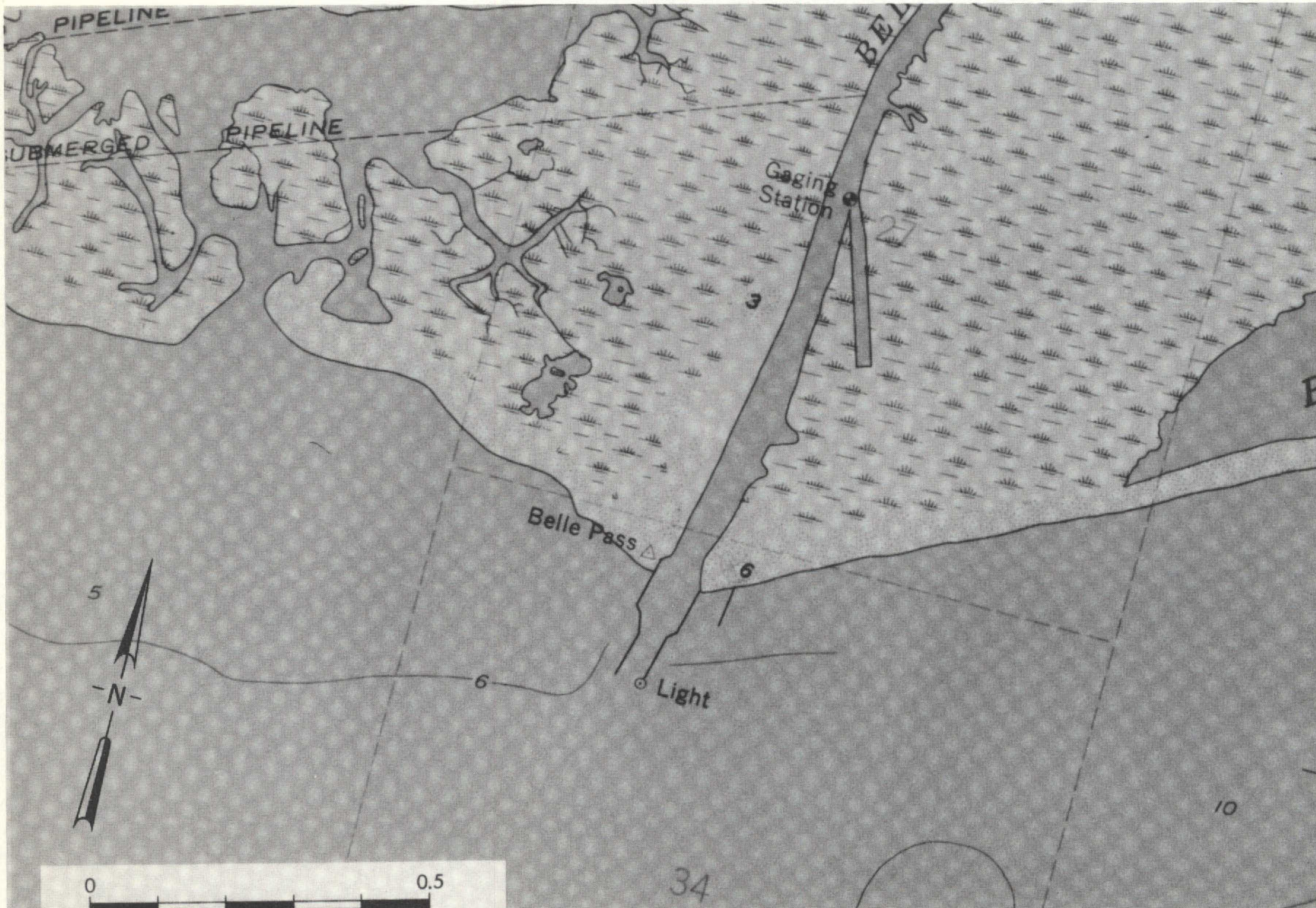
BELLE PASS - 1935

FIG. 3



BELLE PASS - 1945

FIG. 4



BELLE PASS - 1953

FIG. 5

BELLE PASS - 1969

FIG. 6

BELLE PASS - 1972

FIG. 7

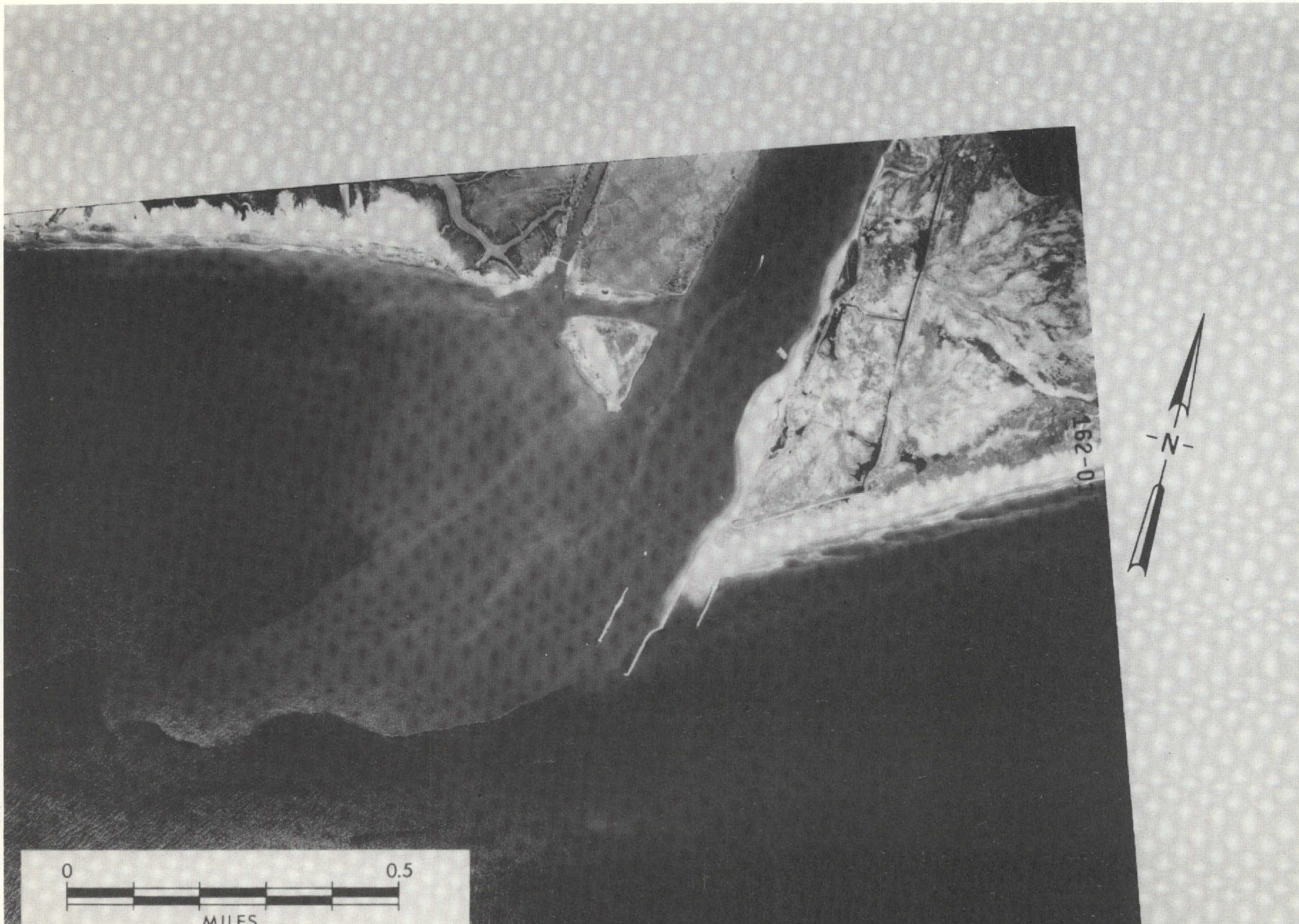
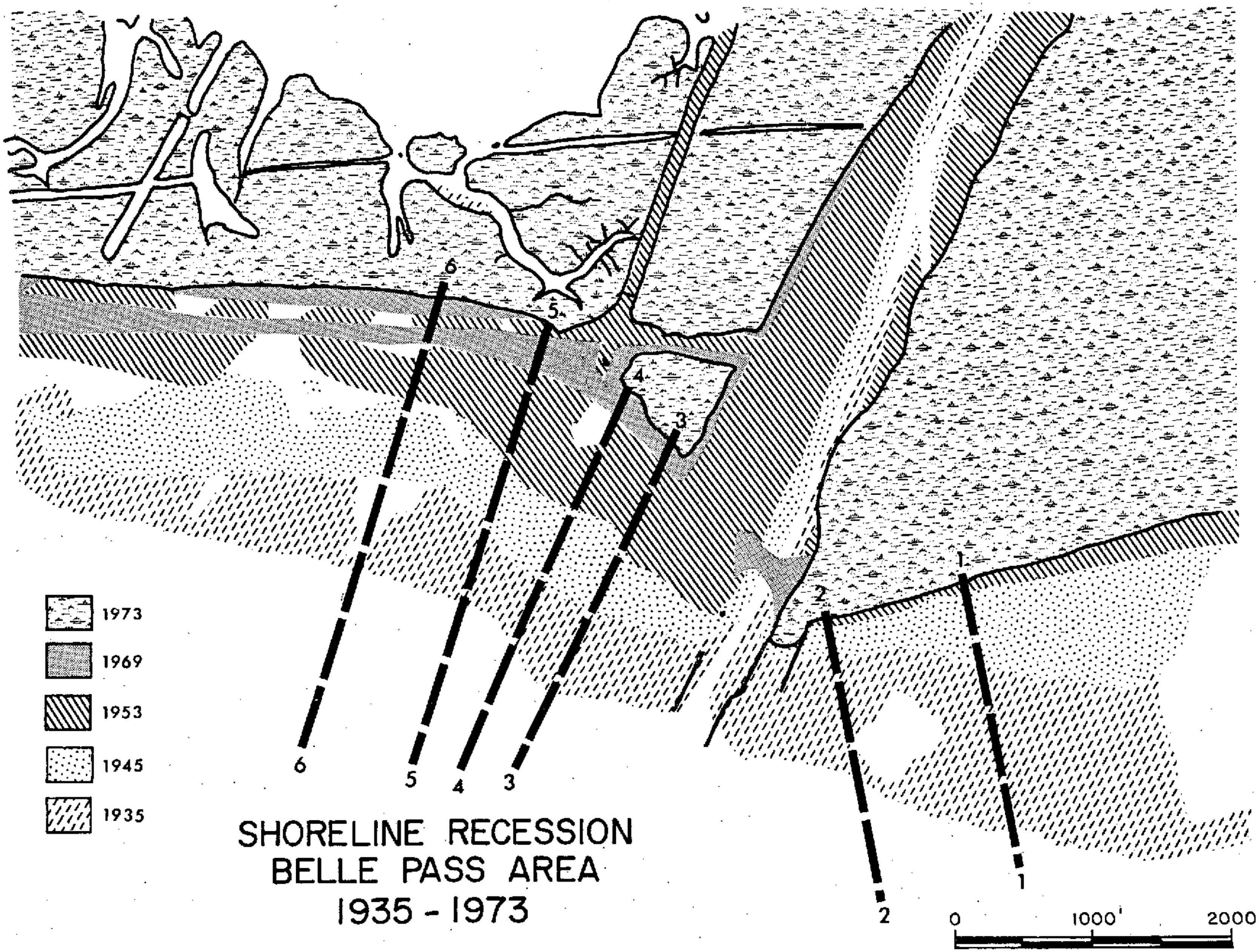


FIG. 8



SHORELINE RECESSION
BELLE PASS AREA
1935 - 1973

FIG. 9A

to the east (Points 1 and 2). There has been much recession on the west side (Points 3, 4, 5 and 6). If the jetty system had not been installed, it is probable that the entire shoreline in the area would have been planed back on a line even with the present west side (Figure 8).

Quantitative recession rates (Table 1) were calculated from the separate line tracings for six chosen areas of interest (indicated on Figure 9A). Included are the calculated periodic changes and annual rates. It should be noted that the recession rates at any point varied greatly from period to period -- an indication of the dependence of the recession on variables other than time: i.e., amount of storm activity, sea state, wind velocity, etc.. Also included in Table 1 are the recession rates calculated from the most recent photographs (August 1972 - September 1973).

The recession rates for the 24- and 28-yr. periods since 1945 are the most dependable long-term values since the existing jetty system was constructed (in about 1939). Before then, the shoreline recession rate had been estimated to be 120 feet/year after Bayou Lafourche was dammed off in 1904 (Peyronnin, 1962). Before that year, the two passes of the bayou furnished enough Mississippi River sediment to the Gulf to prevent more rapid recession.

Three maps of the area for 1845, 1887, and 1947 (Kwon, 1969), not shown here, indicate little or no recession before 1887. Between 1887 and 1947, however, the shoreline receded 3 1/2 miles (about 310 feet per year). Peyronnin (1962), using maps from 1890 and 1960, calculated a total recession of 6,650 ft. (about 95 feet/year). A comparison of an old map dated 1876 (not shown) with the 1935 quadrangle (Fig. 3) indicates an approximate annual recession of 150 feet before construction of the jetties.

These estimated annual rates, it should be emphasized, include some effects from either the jetty system or different storm and hurricane histories or both.

In Cameron Parish, Hurricane Audrey (1957) caused 50-foot beach recessions east of the storm center. At least 19 strong hurricanes have crossed or passed the Louisiana Coast near the Belle Pass area since 1893 and innumerable other Gulf hurricanes and tropical storms have contributed periodic effects.

Modifications and extensions to the jetties, the installation of a groin, the widening of Belle Pass, and the closure of Fourchon Pass will also have caused some distortions in the calculated long-term rates given in Table 1.

It should be noted that the shoreline changes during part of a year may actually be accretions (Areas 1 and 2 from March through August 1973; Area 3 from August through September 1973; and Area 6 from March through September 1973). Such positive changes indicate beach replenishment during very calm seas with southerly to southwesterly winds.

TABLE 1

SHORELINE RECESSION RATES
BELLE PASS AREA
1935-1973
(From Aerial Photographs and Maps)

			CHANGE (FEET)		RATE OF CHANGE (FEET/YEAR)			
AREA*	DATE	DISTANCE TO REFERENCE (FEET)	SINCE 1935	SINCE PREVIOUS DATE	SINCE 1935	SINCE PREVIOUS DATE	SELECTED PERIODS	
1	1935.5	2161	0		0		-125 10 yrs	
	1945.5	910	-1251	-1251	-125	-125		
	1953.5	455	-1706	-455	-95	-57	-24 24 yrs	
	Oct 1969	284	-1877	-171	-55	-10		
	Aug 1972	256	-1905	-28	-51	-10		-24 28 yrs
	Mar 1973	193	-1968	-63	-52	-108		
	May 1973	205	-1956	+12	-52	+72	-33 1 yr	
	Aug 1973	221	-1940	+16	-51	+64		
	Sep 1973	220	-1941	-1	-51	-12		
							1974 Field Study -60 ft. in 0.4 yrs	
2	1935.5	1365	0		0		-85 10 yrs	
	1945.5	512	-853	-853	-85	-85		
	1953.5	398	-967	-114	-54	-14		
	Oct 1969	313	-1052	-85	-31	-5	-9 24 yrs	
	Aug 1972	256	-1109	-57	-30	-20		-11 28 yrs
	Mar 1973	196	-1172	-63	-31	-108		
	May 1973	205	-1160	+12	-31	+72		
	Aug 1973	221	-1144	+16	-30	+64	-52 1 yr	
	Sep 1973	200	-1165	-1	-30	-12		
							1974 Field Study -50 ft. in 0.4 yrs	
3	1935.5	2502	0		0		-57 10 yrs	
	1945.5	1934	-568	-568	-57	-57		
	1953.5	1537	-965	-397	-54	-50		
	Oct 1969	995	-1507	-542	-44	-33	-39 24 yrs	
	Aug 1972	882	-1620	-113	-44	-40		-38 28 yrs
	Mar 1973	883	-1619	+1	-43	+2		
	May 1973	851	-1651	-32	-44	-190		
	Aug 1973	828	-1674	-23	-44	-92	-29 1 yr	
	Sep 1973	851	-1651	+23	-43	+280		
							1974 Field Study -35 ft in 0.4 yrs	

TABLE 1 (cont.)

SHORELINE RECESSION RATES
BELLE PASS AREA
1935-1973
(From Aerial Photographs and Maps)

			CHANGE (FEET)		RATE OF CHANGE (FEET/YEAR)		
AREA*	DATE	DISTANCE TO REFERENCE (FEET)	SINCE 1935	SINCE PREVIOUS DATE	SINCE 1935	SINCE PREVIOUS DATE	SELECTED PERIODS
4	1935.5	2161	0		0		-28 10 yrs
	1945.5	1877	-284	-284	-28	-28	
	1953.5	1308	-853	-569	-47	-71	
	Oct 1969	739	-1422	-568	-41	-35	-52 24 yrs
	Aug 1972	455	-1706	-284	-46	-100	-52 28 yrs
	Mar 1973	386	-1775	-69	-47	-118	
	May 1973	469	-1692	+83	-45	+500	-41 1 yr
	Aug 1973	386	-1775	-83	-46	-330	
	Sep 1973	411	-1750	+25	-46	+300	
5	1935.5	2104	0		0		-51 10 yrs
	1945.5	1592	-512	-512	-51	-51	
	1953.5	1194	-910	-398	-51	-50	
	Oct 1969	682	-1422	-512	-41	-31	-44 24 yrs
	Aug 1972	398	-1706	-284	-46	-100	-46 28 yrs
	Mar 1973	386	-1718	-12	-46	-21	
	May 1973	352	-1752	-34	-46	-200	-97 1 yr
	Aug 1973	331	-1773	-21	-46	-84	
	Sep 1973	293	-1811	-38	-47	-460	
							1974 Field Study -40 ft in 0.4 yrs
6	1935.5	2104	0		0		-57 10 yrs
	1945.5	1536	-568	-568	-57	-57	
	1953.5	967	-1137	-569	-63	-71	
	Oct 1969	569	-1535	-398	-45	-24	-47 24 yrs
	Aug 1972	256	-1848	-318	-50	-112	
	Mar 1973	166	-1938	-90	-51	-150	-46 28 yrs
	May 1973	176	-1928	+10	-51	+60	
	Aug 1973	221	-1883	+45	-49	+180	-19 1 yr
	Sep 1973	235	-1869	+14	-49	+170	

* See Figure 9 A for Locations

It can be concluded, then, that except for unusual circumstances, the net changes over periods longer than one year will be recessions varying in magnitude with wave direction and sea state.

Given the present configuration of the coastline in the Belle Pass area, any wind-waves approaching the shore from east-northeast to southeast will generate east-to-west littoral currents (Whitehurst and Self, 1974). Wind and wave statistics recorded at nearby Grand Isle (Peyronnin, 1962) show that waves from the southeast are predominant both in height and duration, especially those with heights of 2, 3, and 4 feet (durations, respectively, of 2200, 1600, and 540 hrs./yr.). Southeast winds are predominant also in velocity and duration.

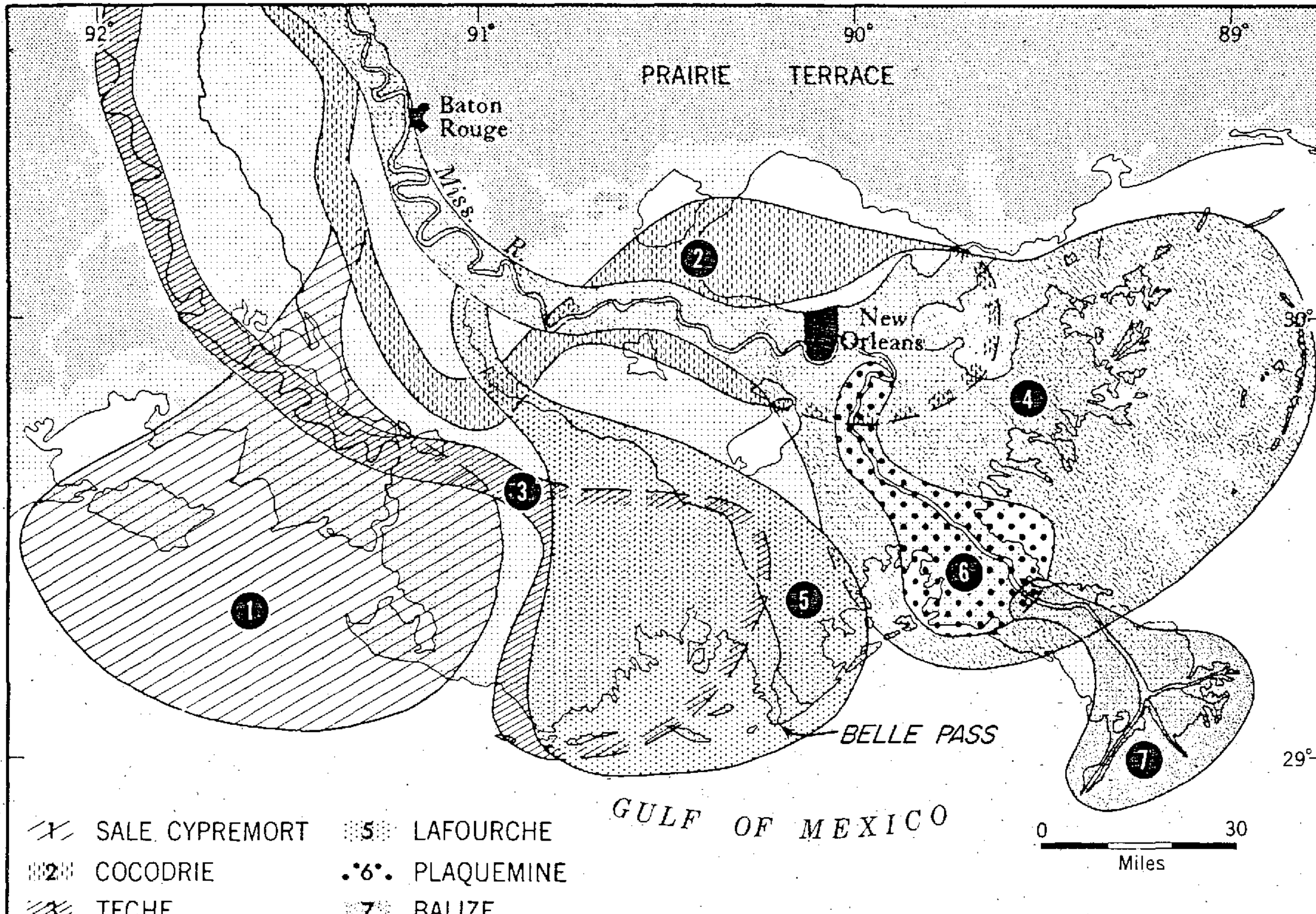
The high coast recession rates in the Belle Pass result from natural subsidence and erosion of a delta (#5, Figure 9B) laid down by a major distributory of the Mississippi River (Lafourche route). This distributory was abandoned about 700 years ago in favor of total flow to the east. Some flood waters and sediment were carried into the Lafourche system until 1904.

The present subsidence rate is estimated to be 1 to 2 feet per year (Peyronnin, 1962) due to consolidation of buried alluvial materials. Older delta lobes (Nos. 1 and 4, Figure 9B), after natural subsidence and erosion, remain as shoals with irregular marshy coastlines. Terrebonne and Timbalier Bays, formerly the deltaic plain of the Mississippi-Teche route (No. 3) are the result of the same processes.

Another important factor in the erosion is the direction of prevailing winds in the Gulf of Mexico. In Figures 9C and 9D, deep-ocean wind waves approaching from the east and east-southeast are refracted (turned), after passing the Mississippi delta, because of the Gulf bottom contours. The direction becomes altered, as the waves approach shallow water, to form the prevailing wave direction. For both east and east-southeast winds, the angle of attack in the Belle Pass area remains toward the northwest with resultant east-to-west littoral currents. To the east of the pass, the angle of approach is either perpendicular to the shoreline or to the north with resultant west-to-east littoral currents. This split in direction of wave approach varies in location and with time, but mostly it remains east of Bay Champagne.

Thus the Belle Pass area receives little or no sediment from the east for beach replenishment and is subject to continuous erosion. It can safely be stated that the gradual retreat of the bay-mouth islands at Bay Champagne, the disappearance of Bay Marchand, and the erosion east of the Belle Pass jetty are the result of such seasonal winds, with Gulf storms and hurricanes adding intermittent contributions of very large waves, storm surges, and inundation with consequent high recession rates.

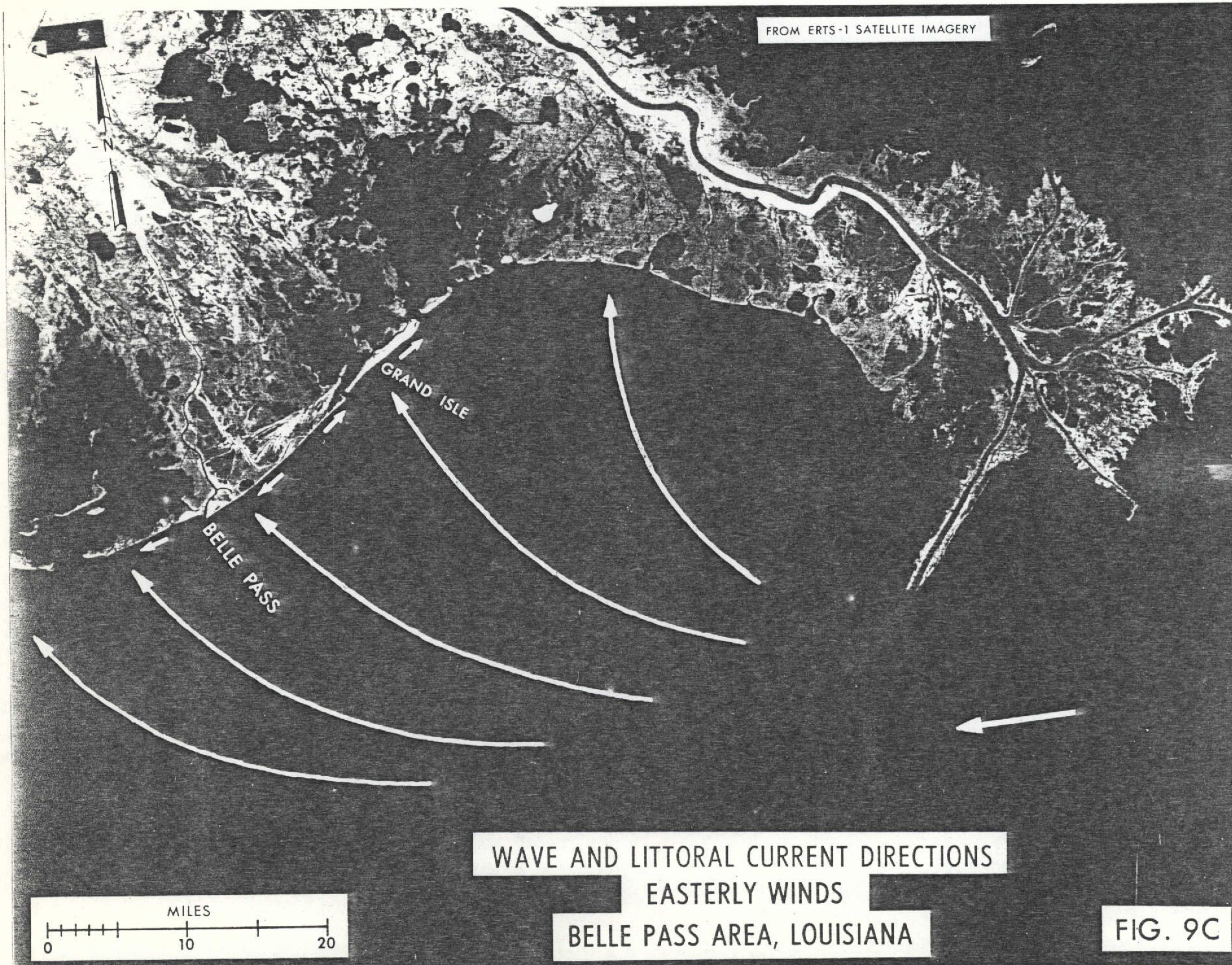
As noted before, the existing east jetty has not prevented shoreline recession except at the point of land immediately to the east. Even before 1945 (Figure 4), the two jetties had to be extended shoreward due to recession. The extensions included transition sections to provide a width of 400 feet. (The original jetties



RECENT MISSISSIPPI RIVER DELTAS

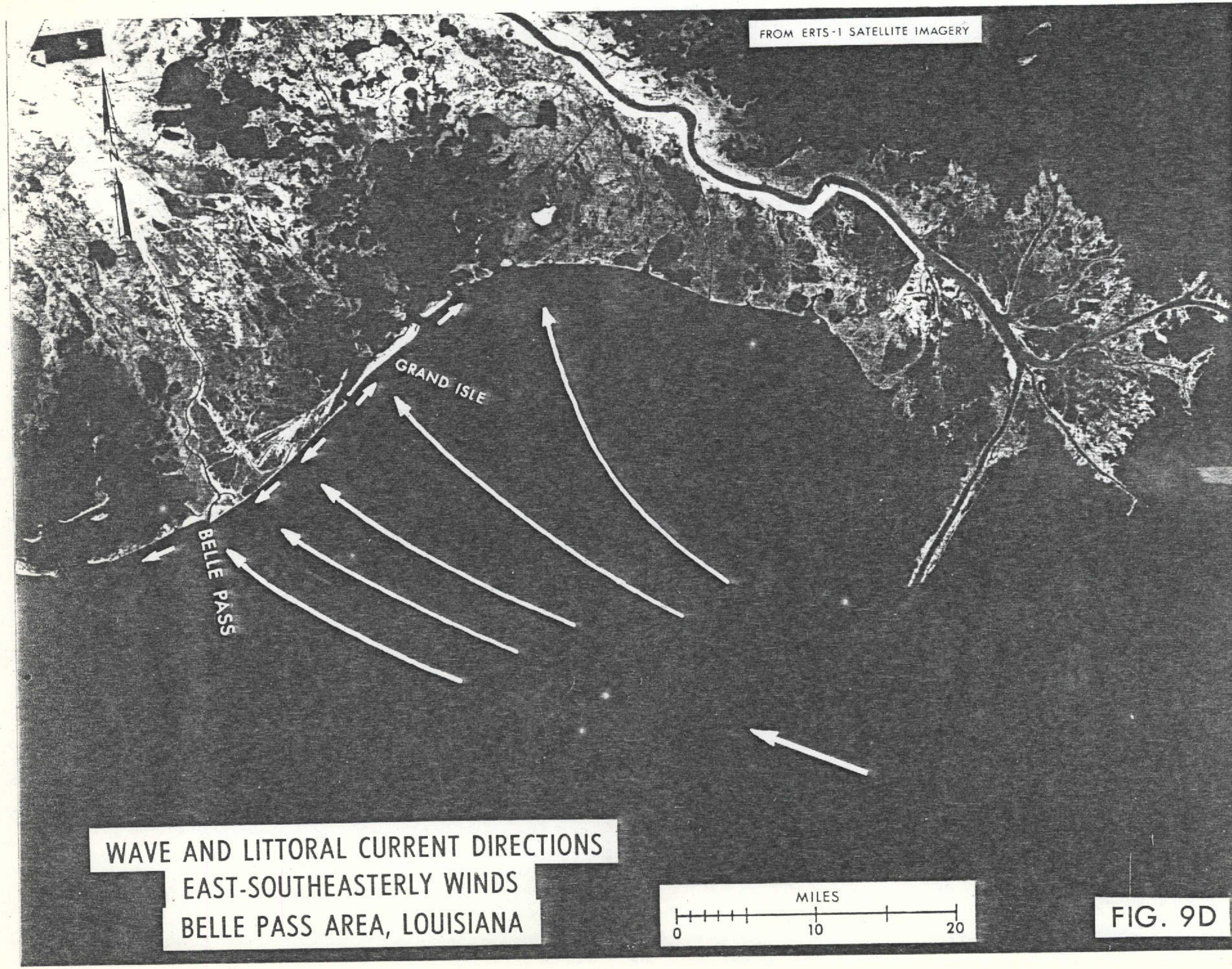
FIG. 9B

After Coleman and Gagliano, 1964



WAVE AND LITTORAL CURRENT DIRECTIONS
EASTERLY WINDS
BELLE PASS AREA, LOUISIANA

FIG. 9C



WAVE AND LITTORAL CURRENT DIRECTIONS
EAST-SOUTHEASTERLY WINDS
BELLE PASS AREA, LOUISIANA

FIG. 9D

were only 200 feet wide.) (Louisiana Dept. of Public Works, 1960)

Between 1945 and 1953, a groin was installed to the east (Figure 5). It apparently had the desired effect of protecting the shoreward end of the east jetty (see Figure 9A). In 1958, a 500-foot section of the west jetty was removed and rebuilt to provide a width of 320 feet at the Gulf end. Bayou Lafourche was also dredged and widened.

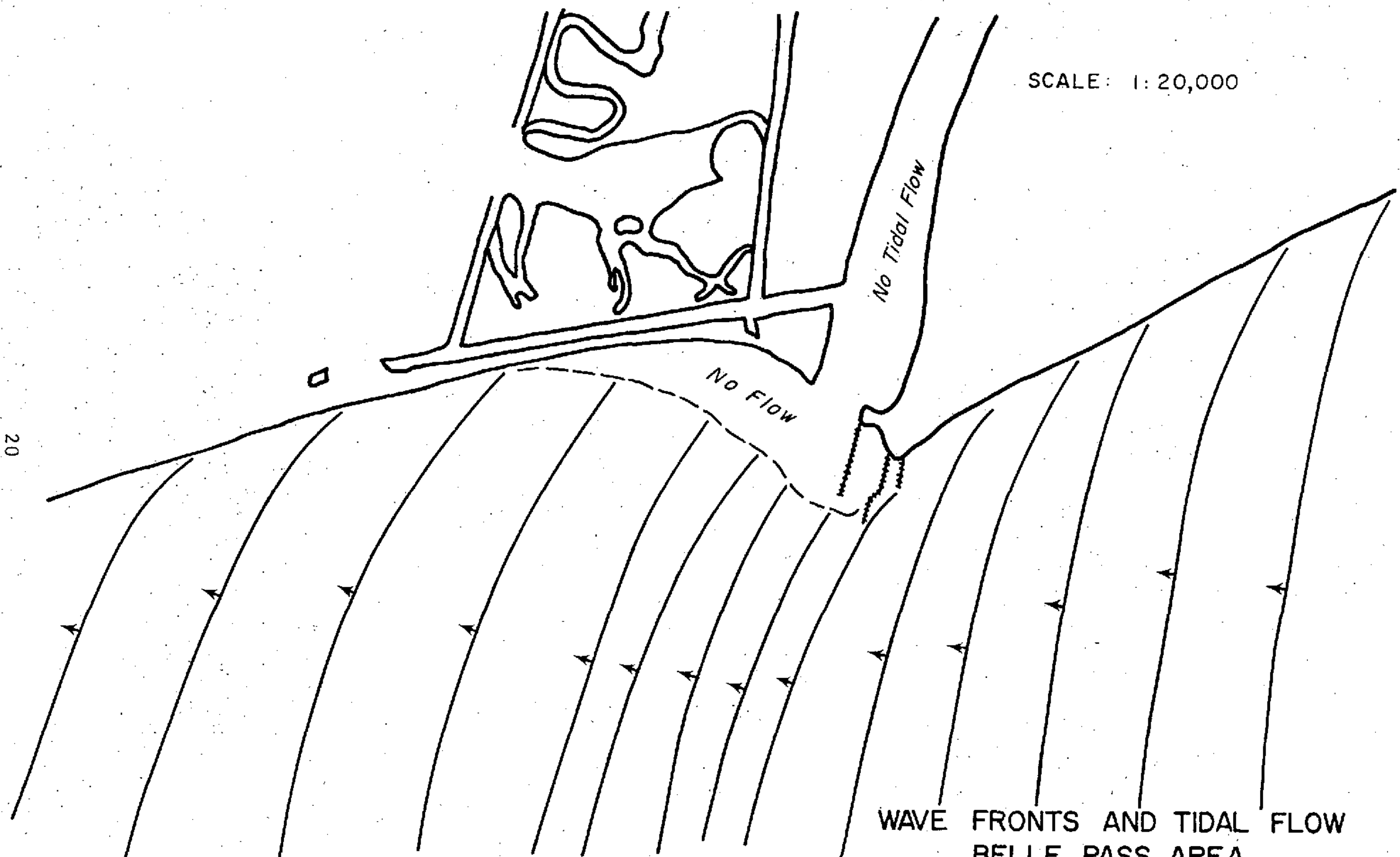
The east jetty and groin have served as a hinge point for coastline to the east, with the shore having been planed back from Bayou Moreau to the jetties. Although the original jetties were constructed perpendicular to the 1939 shoreline at Belle Pass, at present the east jetty extends into the Gulf at an angle of 130 degrees (a 40-degree change in relation to the coastline). The partial failure of the jetty to act as a typical accretion structure most probably resulted from the slow change to an inefficient orientation with respect to the littoral currents. Peyronnin (1962) states that the degeneration of the Belle Pass area has been the main supply of fresh material to the Timbalier Islands and Isles Dermieres.

The lower half of the bayou has been a tidal estuary since 1904, with the fresh-water from the Donaldsonville pumping station and inflow from Company Canal and the Intracoastal Waterway having little effect on the flow patterns at Belle Pass. Suspended sediment is introduced from the Intracoastal Waterway at Larose and the Southwestern Louisiana Canal at Leeville and from the channel bottom by boat traffic. Conductivity measurements in 1972 and 1973 also indicated that Gulf salt water intrudes as far upstream as Larose (Whitehurst, 1974).

Wave-front and tidal-flow diagrams (Figures 10-17) were traced from the available aerial photographs. In each photograph, the observable littoral current was moving from east to west (waves approaching from east-northeast to southeast). However, each figure demonstrates the variety of conditions resulting from differences in wave approach, longshore current velocity, and the magnitude and direction of tidal flow in the pass.

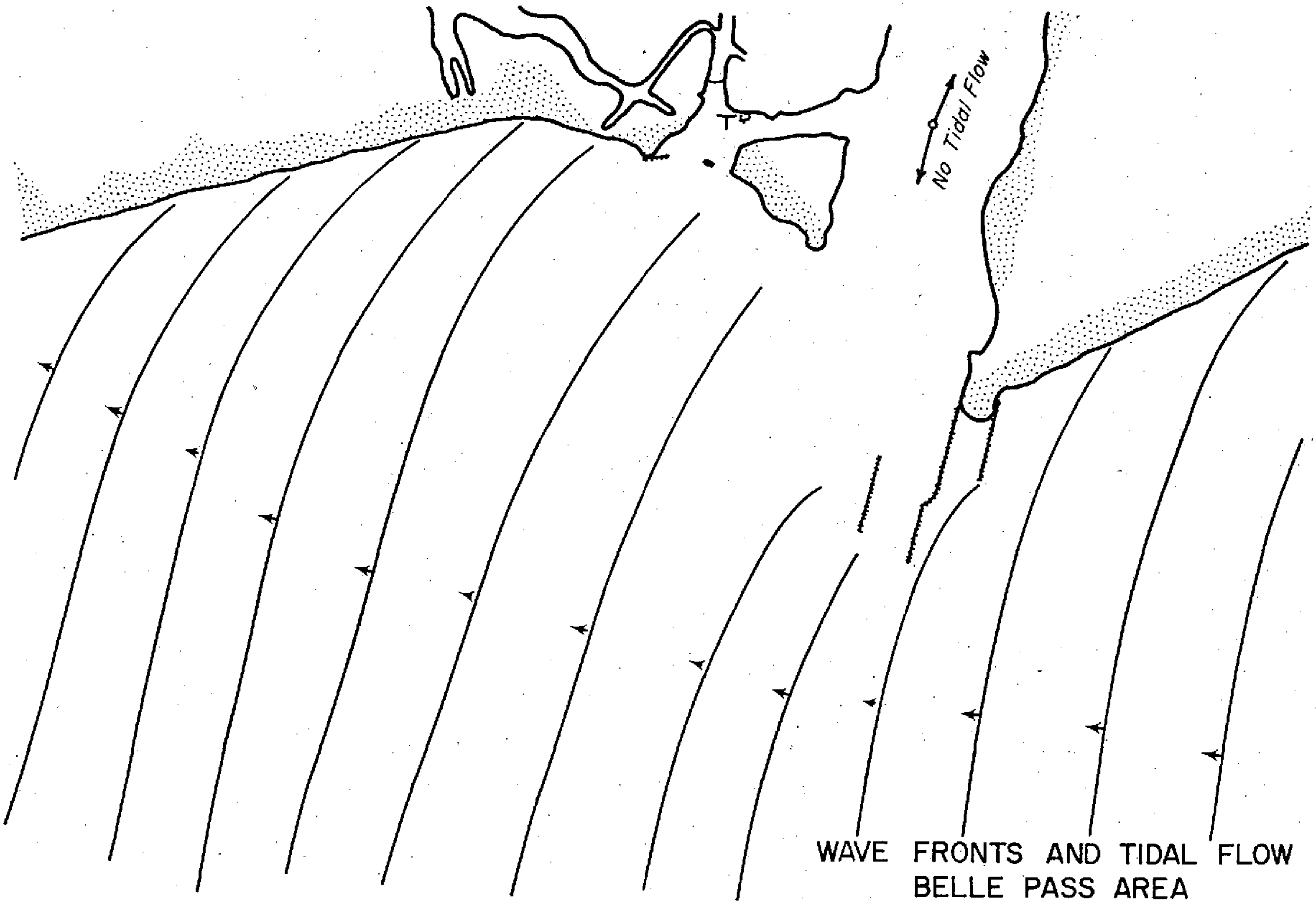
The photographs were also used to study the turbidity patterned by littoral currents and tidal flows. In October 1969 (Figure 6, Figure 10) the photograph was taken when there was no tidal flow. This typical case is shown by the indefinite turbidity in the channel. East-to-west littoral drift is clearly indicated by the lines of turbid and clear water along the east shoreline. The turbid water, deflected around the jetty apparently returns to the nearshore zone at a point just off the left edge of Figure 6.

Four other examples show the case of ebb flow with east-to-west littoral drift. Figure 11 (Also Figure 7) has a distinct zone east of the jetty where sediment is moving west with the littoral current. Additional sediment is being added west of



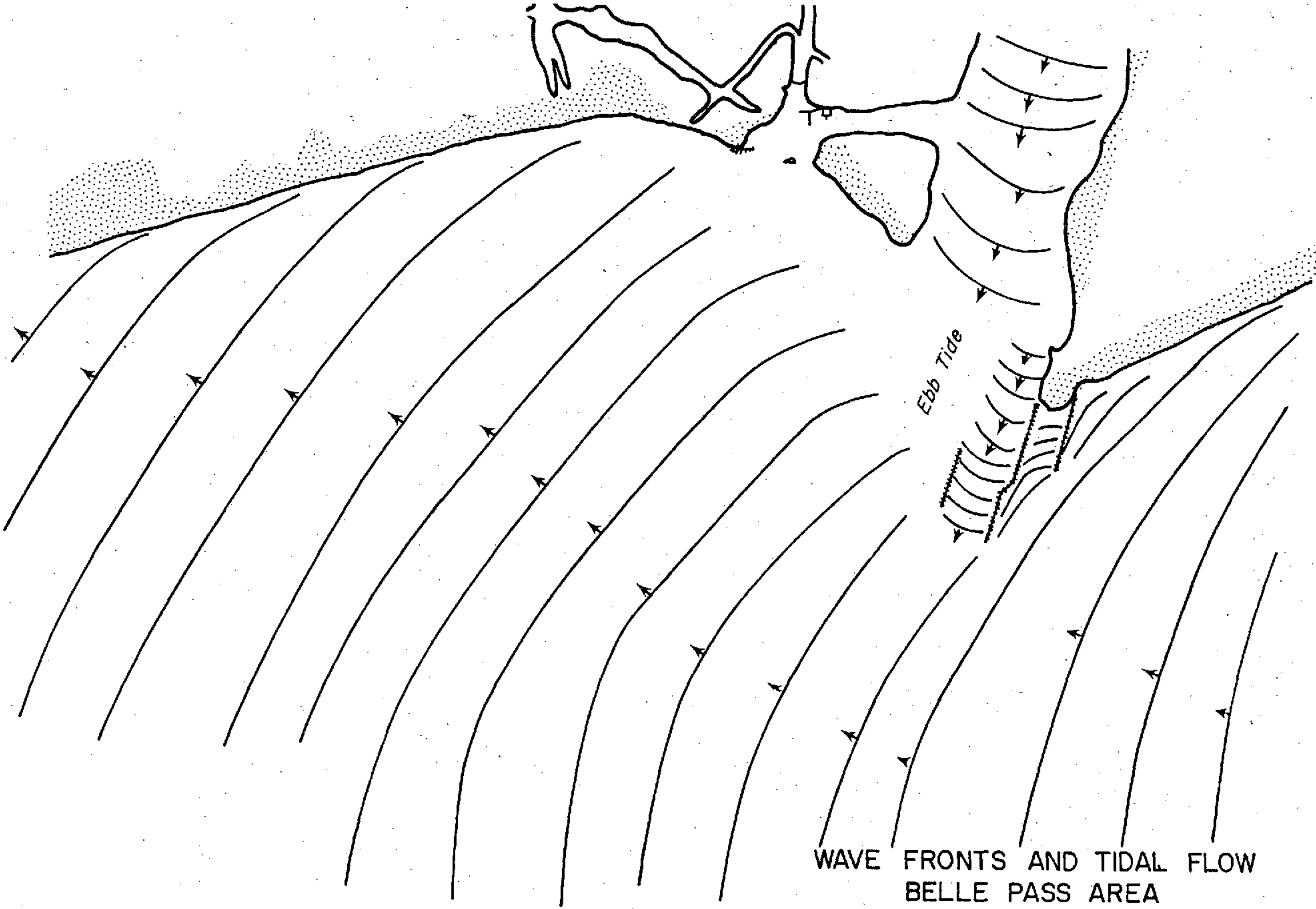
WAVE FRONTS AND TIDAL FLOW
BELLE PASS AREA
OCTOBER, 1969

FIG. 10



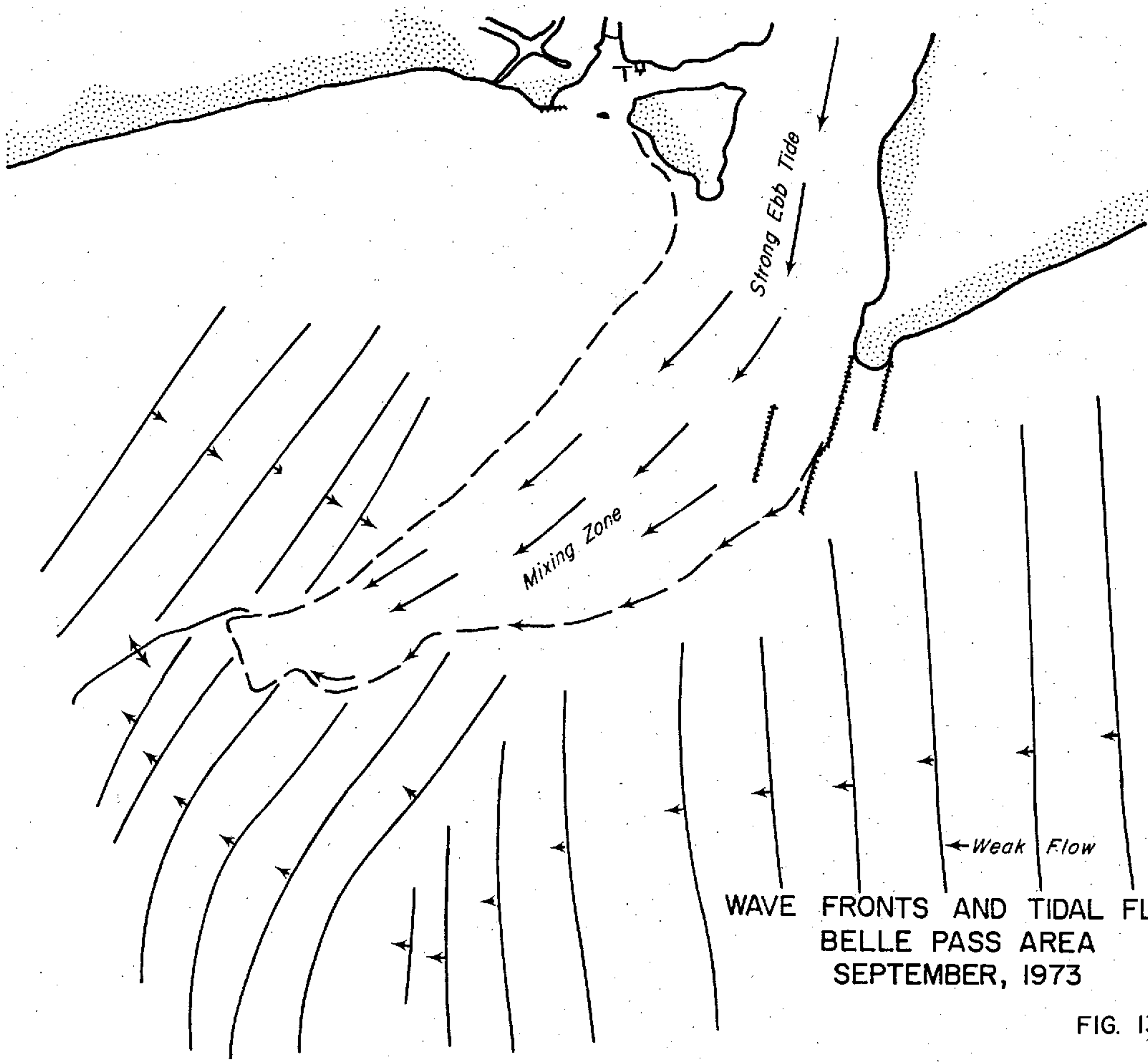
WAVE FRONTS AND TIDAL FLOW
BELLE PASS AREA
AUGUST, 1972

FIG. 11



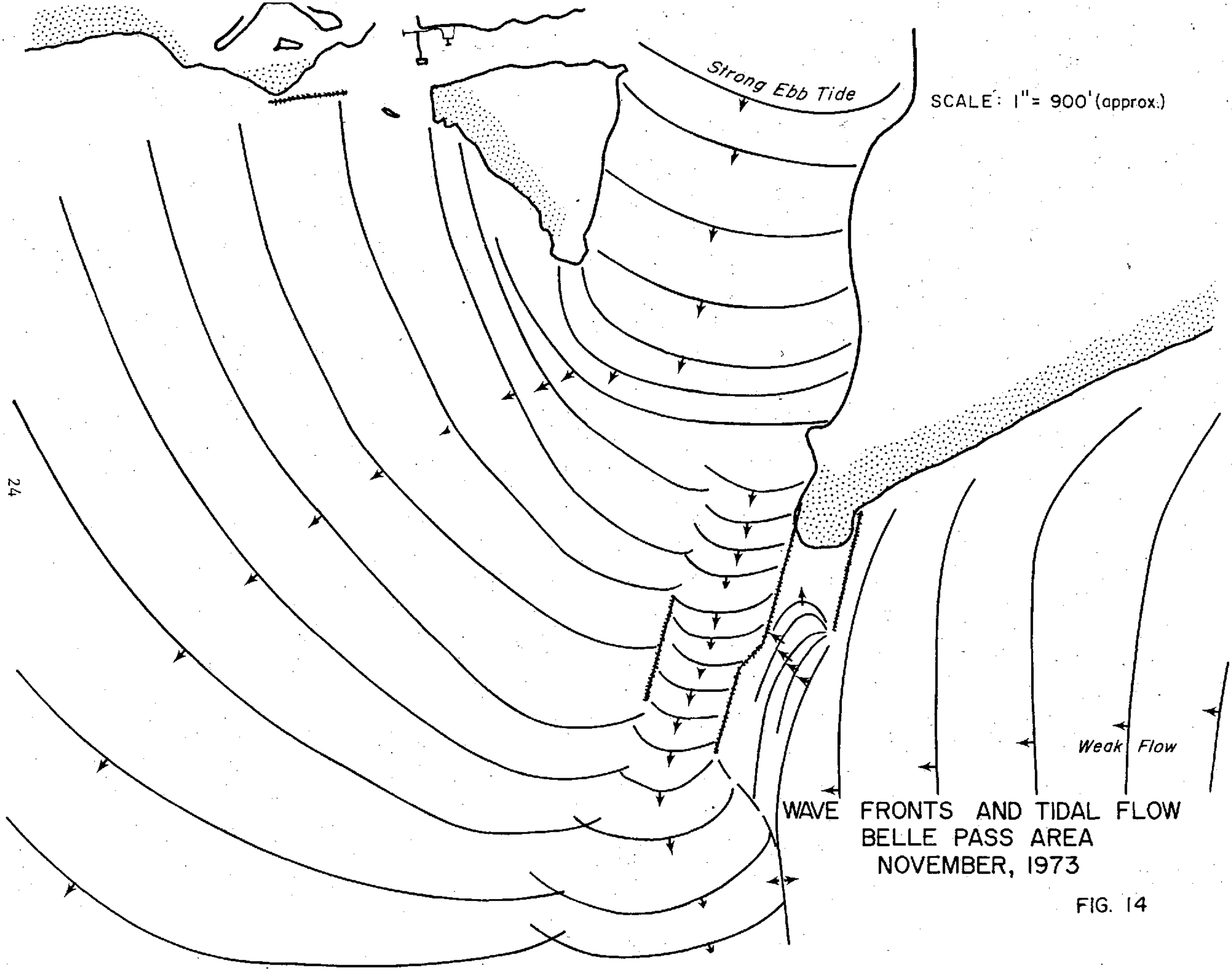
WAVE FRONTS AND TIDAL FLOW
BELLE PASS AREA
MAY, 1973

FIG. 12



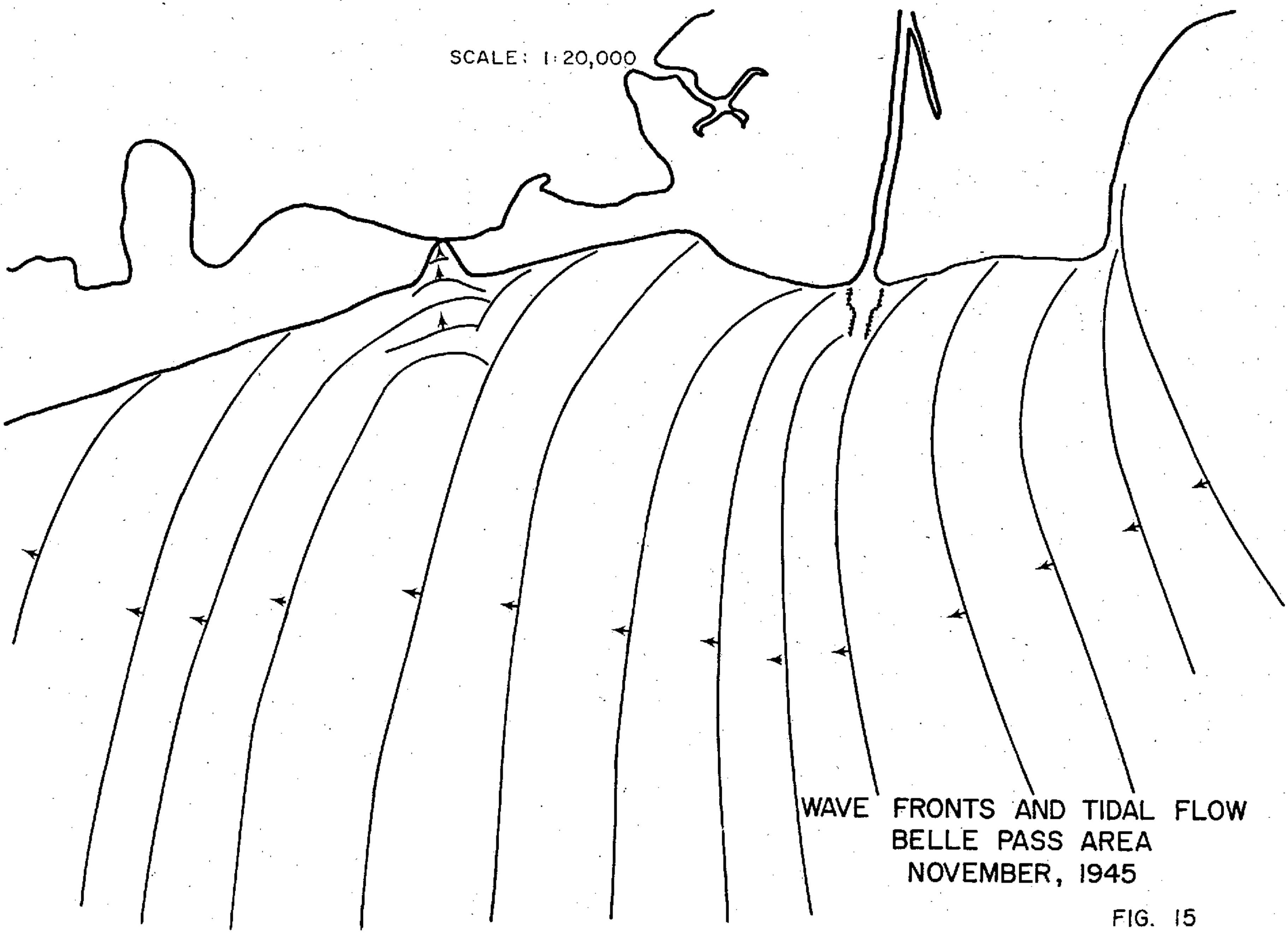
WAVE FRONTS AND TIDAL FLOW
BELLE PASS AREA
SEPTEMBER, 1973

FIG. 13



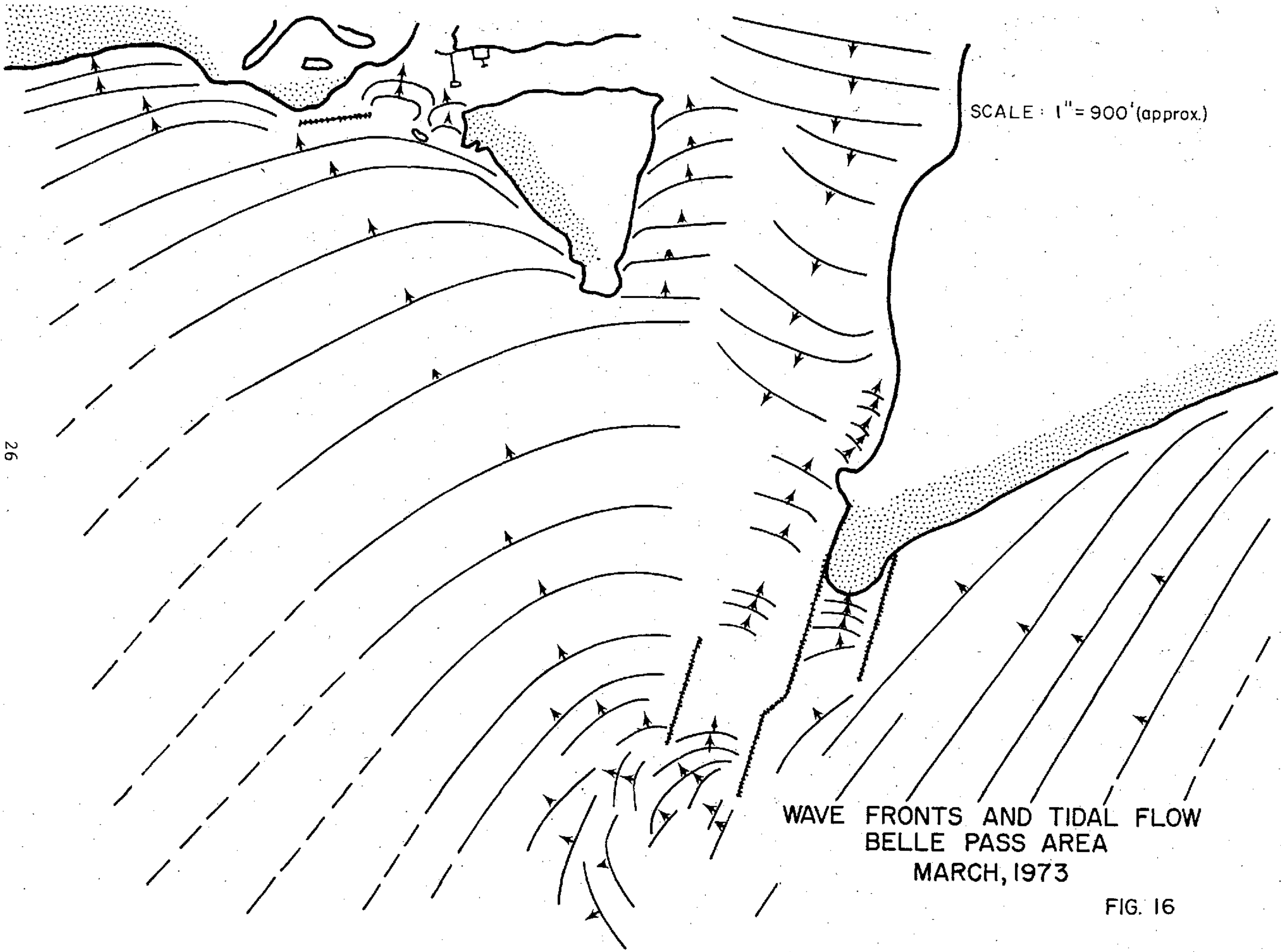
WAVE FRONTS AND TIDAL FLOW
BELLE PASS AREA
NOVEMBER, 1973

FIG. 14



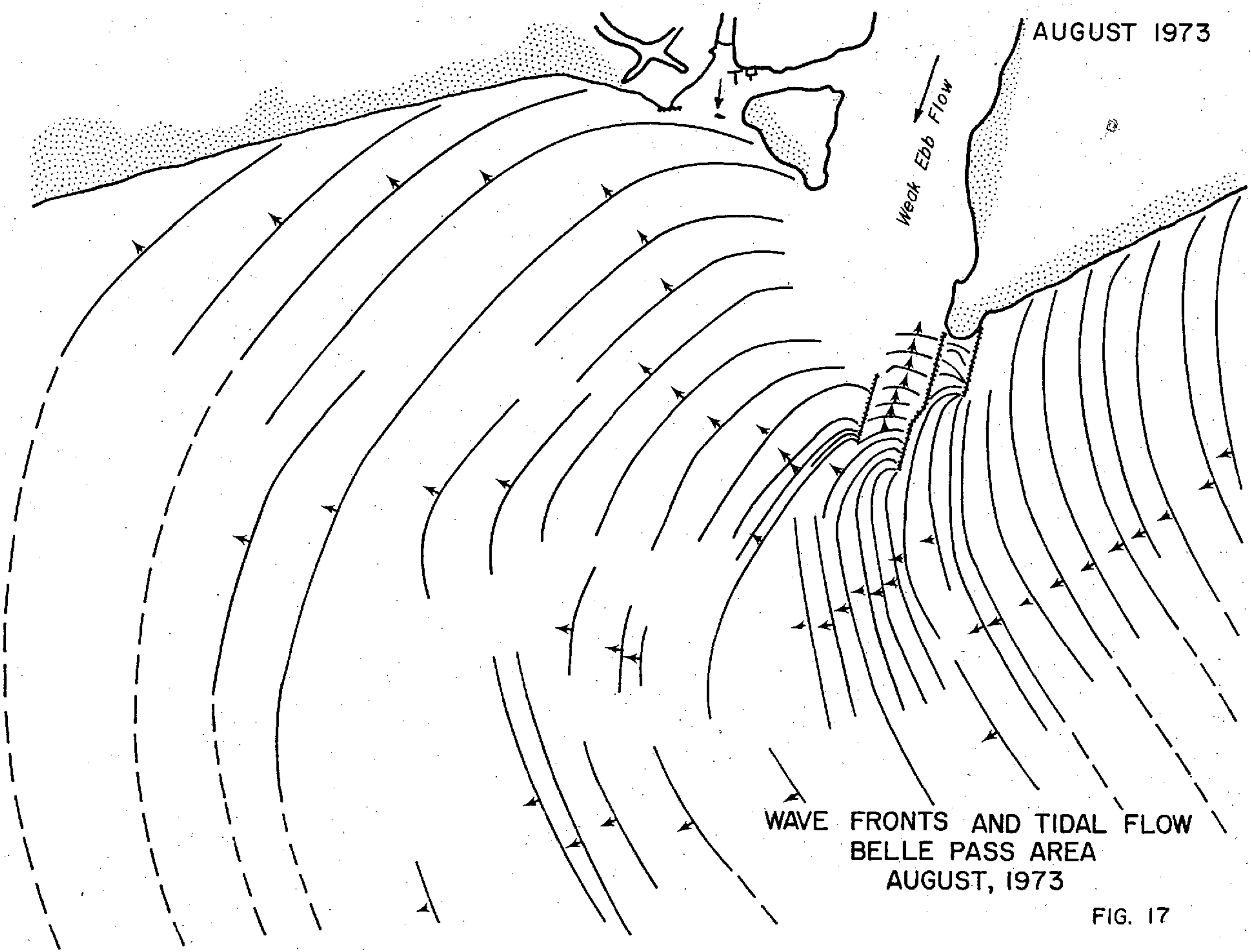
WAVE FRONTS AND TIDAL FLOW
BELLE PASS AREA
NOVEMBER, 1945

FIG. 15



WAVE FRONTS AND TIDAL FLOW
BELLE PASS AREA
MARCH, 1973

FIG. 16



WAVE FRONTS AND TIDAL FLOW
BELLE PASS AREA
AUGUST, 1973

FIG. 17

the jetty by turbid ebb flow from the bayou. Again, it is also apparent that the sediment transport zone is returning to shore at a point just off the left limit of the figure. Figure 12 (May 1973), Figures 8 and 13 (Sept. 1973), and Figure 14 (Nov. 1973) represent the case of strong channel ebb flow with weak or moderate east-to-west littoral current. When the September photograph was taken, the flow pattern had not stabilized after reversal of the tide (the ebb flow plume had not developed fully in the deflected littoral zone).

Figures 16 and 17 demonstrate wave diffraction (bending) which occurs at the tip of a projecting structure such as a breakwater. Wave energy is transferred laterally along the crests and new, smaller waves are propagated at right angles to the original ones. The size of the diffracted waves, in relation to the original waves, increases with the distance from the obstruction. Such diffraction around a jetty is the reason for recession on the downdrift side, and, in the case of Belle Pass, the cause of varying shoreline recession immediately west of the channel.

The flow patterns observed from the photographs indicate that the nearshore littoral drift returns to normal about 5000 to 8000 feet west of the jetty, depending on the tidal flow direction.

III. FIELD STUDY

The remote sensing study was supplemented by periodic hydraulic measurements, ground observations, and physical measurements of beach erosion from January through June 1974. Littoral flow patterns and velocities were also observed to verify the data obtained from the aerial photographs.

Four reference stakes (1" dia. X 8' steel rods) were driven into the beaches both east and west of the jetty for periodic measurement of shoreline changes. Stakes No. 1, 3, and 4 were set on January 17, 1974 and Stake No. 2 was driven on February 2, 1974. (Stake No. 1 had the same approximate location as Area 1 in Figure 9; No. 2, Area 2; No. 3, Area 3; No. 4, Area 5.) Other natural and man-made features were also used as guides for measuring or observing changes (Figure 18A).

The erosion data obtained during the field study (Table 2) illustrate seasonal variations in recession rates. These values are approximate because the location of the water line at mean sea level had to be estimated. The total recession for each stake during the 146-day period, extrapolated to 365 days (third column, bottom) is large compared to those obtained from the March-September 1973. However, the surf was unusually rough during the field study period, and on many days, too rough to obtain data. Probably, the net recessions at the end of 1974 will be less than those shown and will depend on the weather and seas for the remainder of the year.

Special consideration should be given to the narrow point of land at Stake No. 2 (Figure 18A). Although this area has been in equilibrium since at least 1953, it was subject to recession during the 1974 field study (-7 feet average, Table 2). On August 6, 1974, the distance across the point from shore to channel was only 160 feet. A breach at this point would widen rapidly, with consequent serious shoaling of the channel at the north end of the existing jetty.

Wave action on the mud spoil banks of the remnant oil company canal and tidal flow north of the small island at the west side of the pass during the 5-month field study continued to threaten the oil storage facility and concrete dam in this area. The dam was undermined and became ineffective. Muddy surf water, overrunning the beach, entered the backlying marsh streams and ponds and caused many fish to leave for clearer waters.

The other objective of the field study was the obtaining of hydraulic data to supplement and verify the photographic data. A special subsurface float (Figure 18B) was designed and fabricated to observe the littoral currents passing around the jetty.

TABLE 2

SHORELINE RECESSION RATES

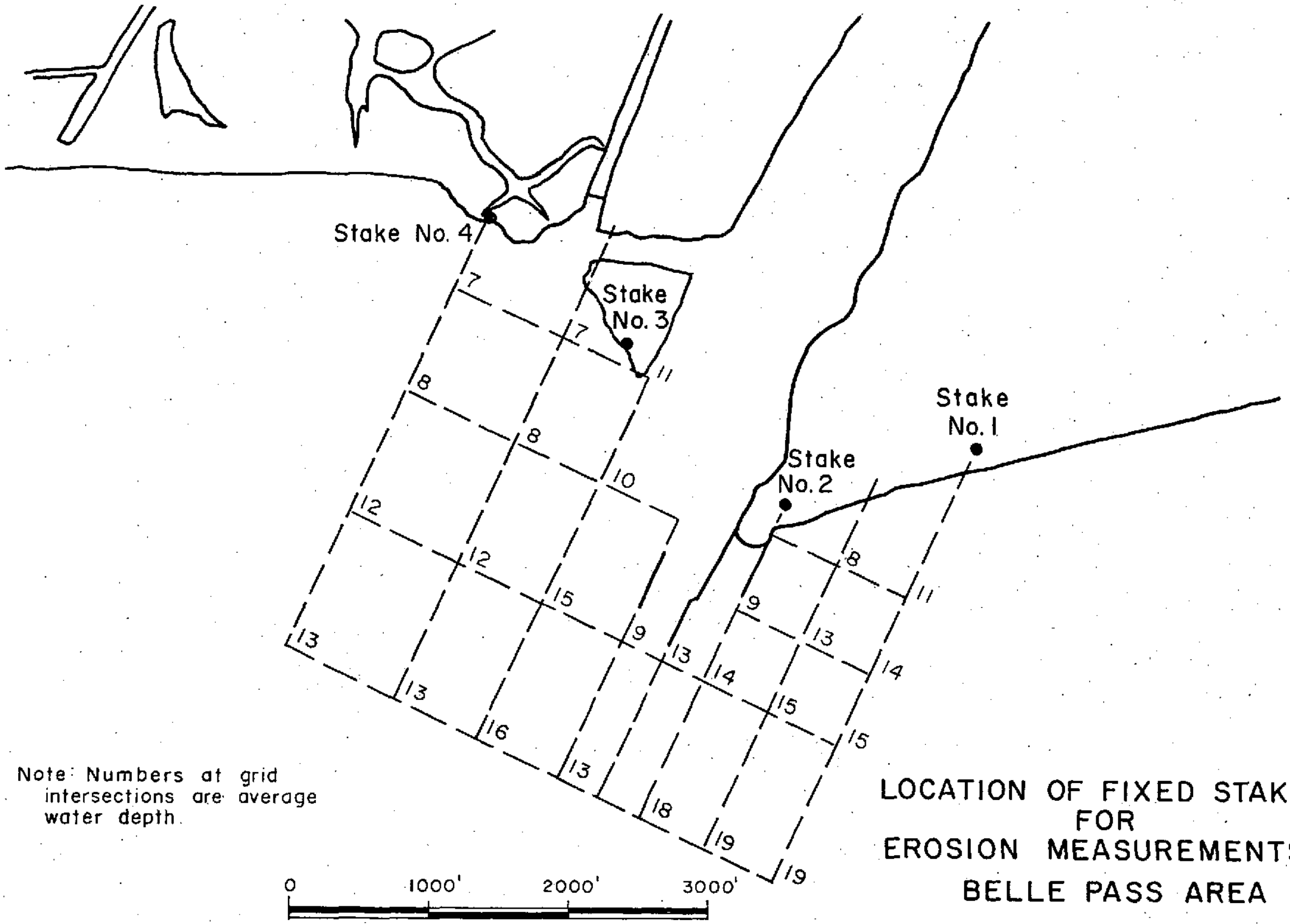
BELLE PASS AREA

(Field Measurements)

January 17 - June 12, 1974

DATE	STAKE NO.	CHANGE* (Feet)		RATE OF CHANGE (Feet per Day)		RATE OF CHANGE (Feet per Year)
		SINCE JAN. 17	SINCE PREVIOUS DATE	SINCE JAN. 17	SINCE PREVIOUS DATE	SINCE PREVIOUS DATE
FEB. 7 (21 Days)	1	-10	-10	-0.48	-0.48	-8
	2	0	0	0	0	0
	3	0	0	0	0	0
	4	0	0	0	0	0
FEB. 25 (39 Days)	1	-6	+4	-0.15	+0.22	+4
	2	0	0	0	0	0
	3	0	0	0	0	0
	4	-1.5	-1.5	-0.04	-0.08	+2
MAR. 16 (58 Days)	1	-20	-14	-0.34	-0.74	-14
	2	-10	-10	-0.17	-0.53	-10
	3	-5	-5	-0.08	-0.26	-5
	4	-3	-1.5	-0.05	-0.08	-2
APR. 10 (83 Days)	1	-30	-10	-0.36	-0.40	-6
	2	-20	-10	-0.24	-0.40	-6
	3	-5	0	-0.06	0	0
	4	-20	-17	-0.24	-0.68	-10
MAY 3 (106 Days)	1	-40	-10	-0.38	-0.44	-7
	2	-30	-10	-0.28	-0.44	-7
	3	-10	-5	-0.09	-0.22	-3
	4	-30	-10	-0.28	-0.44	-7
MAY 13 (116 Days)	1	-60	-20	-0.52	-2.00	-73
	2	-50	-20	-0.43	-2.00	-73
	3	-30	-20	-0.26	-2.00	-73
	4	-40	-10	-0.34	-1.00	-37
JUN. 12 (146 Days)	1	-60	0	-0.41	0	0
	2	-50	0	-0.34	0	0
	3	-35	-5	-0.24	-0.17	-2
	4	-40	0	-0.27	0	0
AVERAGE (0.4 yrs)	1	-30	-8.6	-0.38	-0.55	-22
	2	-25	-7.1	-0.21	-0.48	-18
	3	-18	-5.0	-0.10	-0.38	-13
	4	-20	-5.7	-0.17	-0.34	-9
MAXIMUM (Feet per Year)	1			-150	-21	
	2			-125	-18	
	3			-88	-13	
	4			-100	-14	

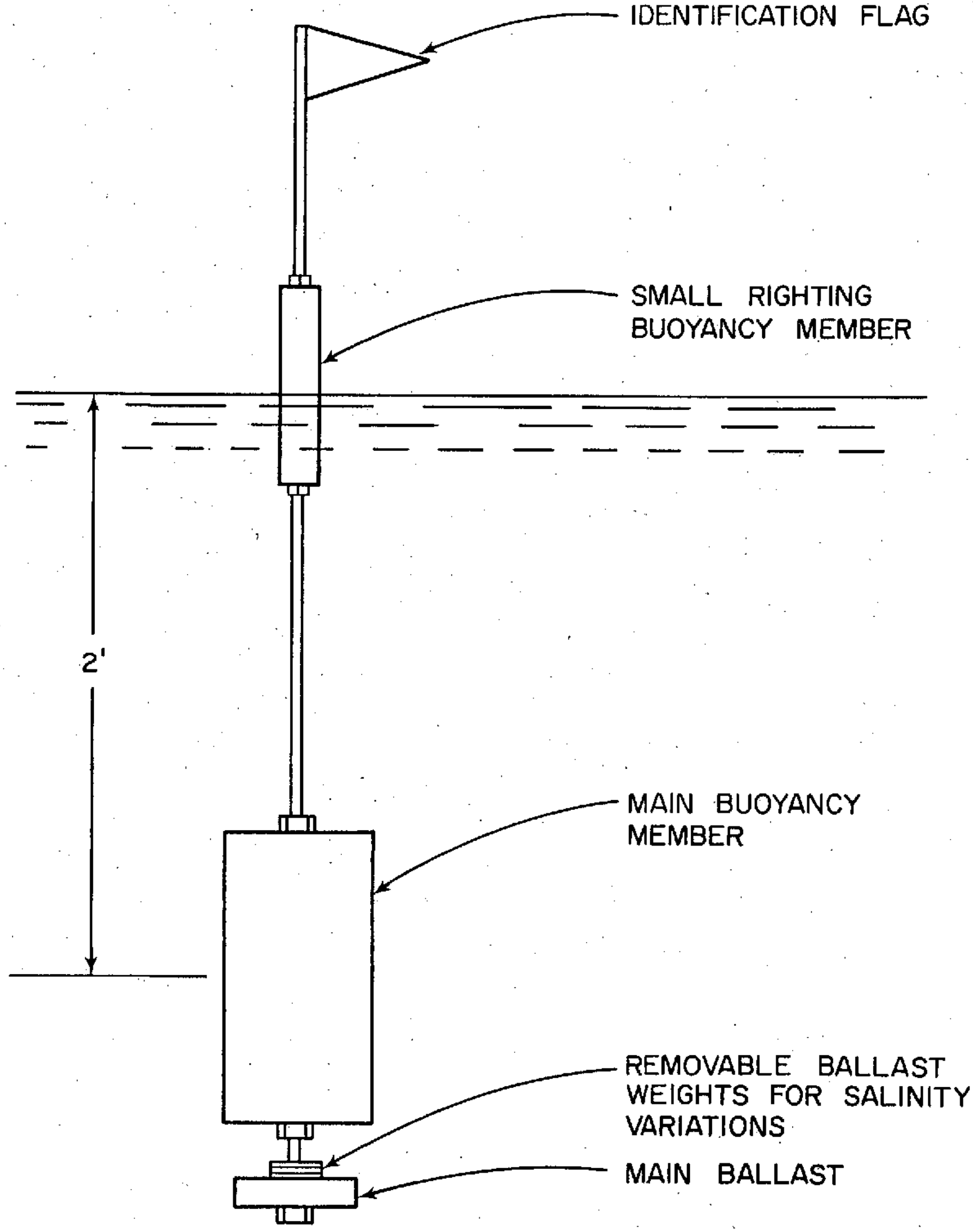
* Measured from estimated water line at mean sea level



Note: Numbers at grid intersections are average water depth.

LOCATION OF FIXED STAKES FOR EROSION MEASUREMENTS BELLE PASS AREA

FIG. 18 A



SUBSURFACE FLOAT

FIG. 18B

The float, designed so that the surface winds would have very little effect on its drift path, moved with the littoral current, both in speed and direction.

The float, released east of the jetty, was followed as it passed around the end of the jetty and its speed measured at intervals to establish velocities along the streamline. On February 25, 1974, the float was used to obtain a typical streamline. This line is also typical of the flow obtained from the aerial photographs. The results from the float test were used to verify the physical model discussed in the next section.

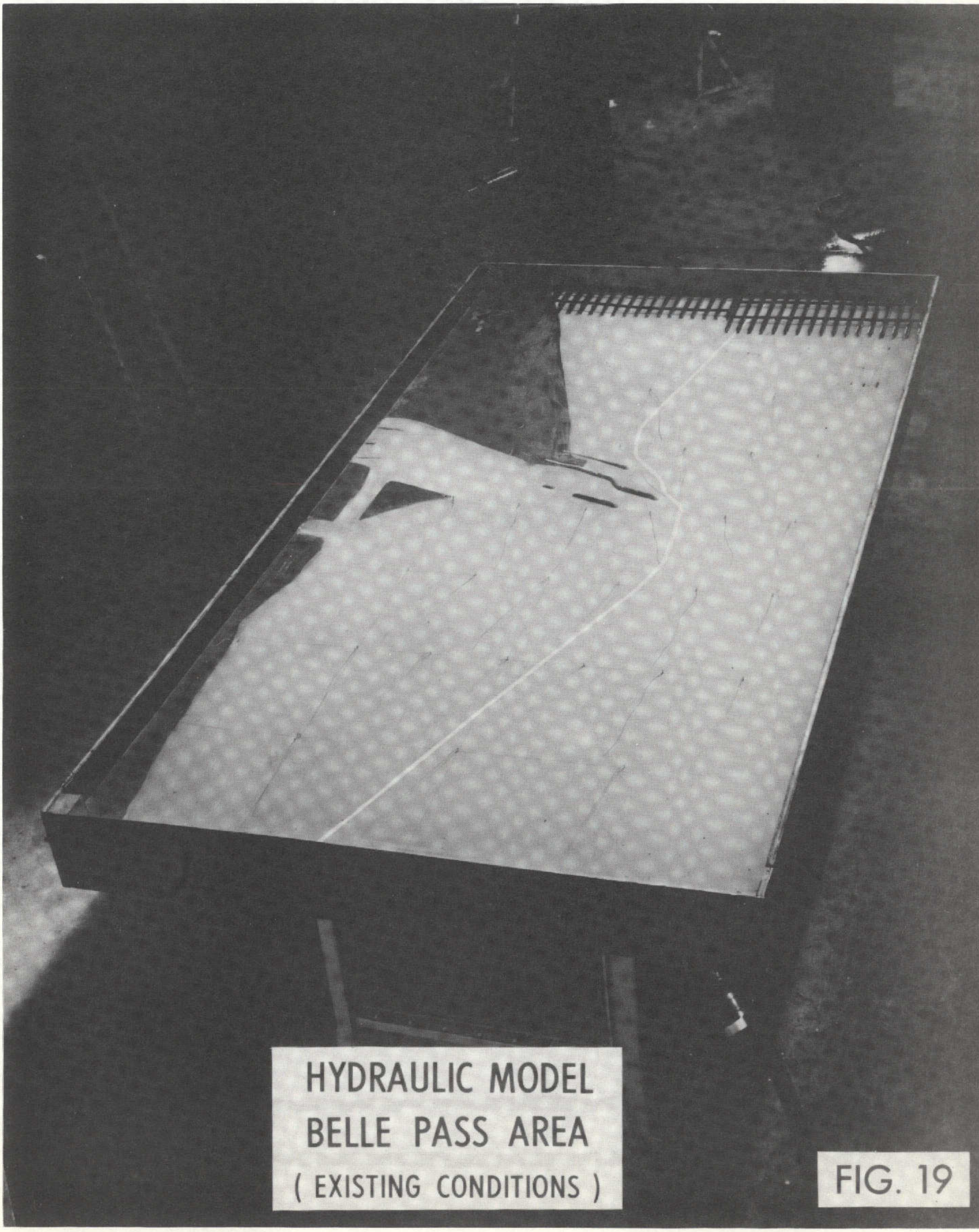
IV. MODEL STUDY

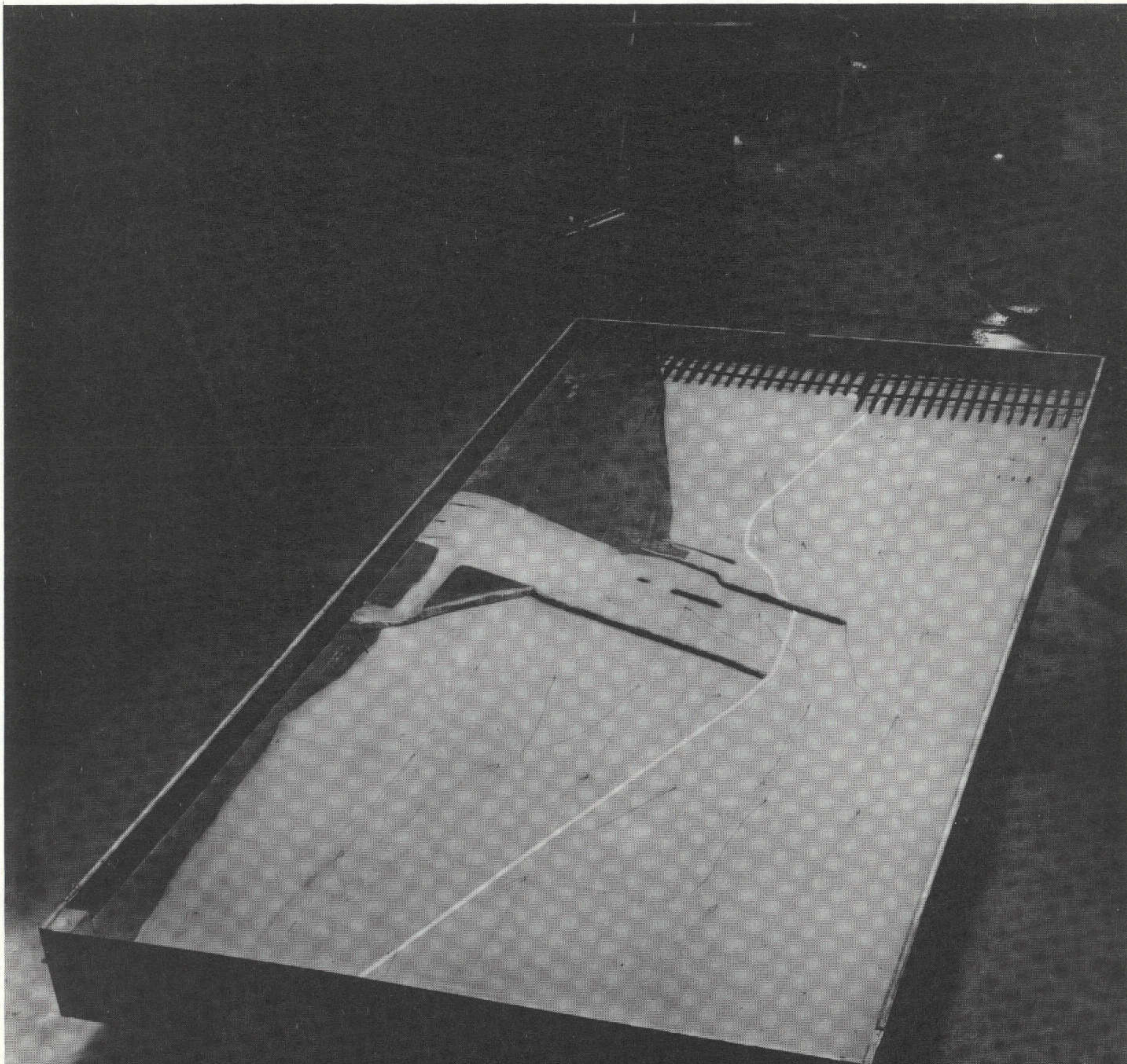
A 4' x 8' scale model of the Belle Pass area was constructed as an aid to further study of flow patterns and velocities and to help predict the effect of the proposed jetty system. Data obtained from aerial photographs and from the field study were used to verify the similarity of the model to the prototype.

The model is shown in Figures 19 and 20. The typical streamline obtained from float observations is shown by white tape. At the far (west) end, three separate rows of water inlet tubes (blocked from view by stilling baffles) were controlled by valves to allow directional variations in the flow toward the jetty. Another set of inlet-outlet tubes installed in the long (north) side could be regulated to provide variable ebb or flood flows in the Belle Pass channel.

One-foot black threads were attached to pins at grid points on the model. After a chosen rate of flow stabilized, the threads became oriented to the flow directions and provided an excellent demonstration of the various flow patterns. A miniature float was released at key points and allowed to trace out a given streamline. Its progress was plotted and timed to establish flow velocities. Photographs were taken of each test to record the flow patterns indicated by the streamers.

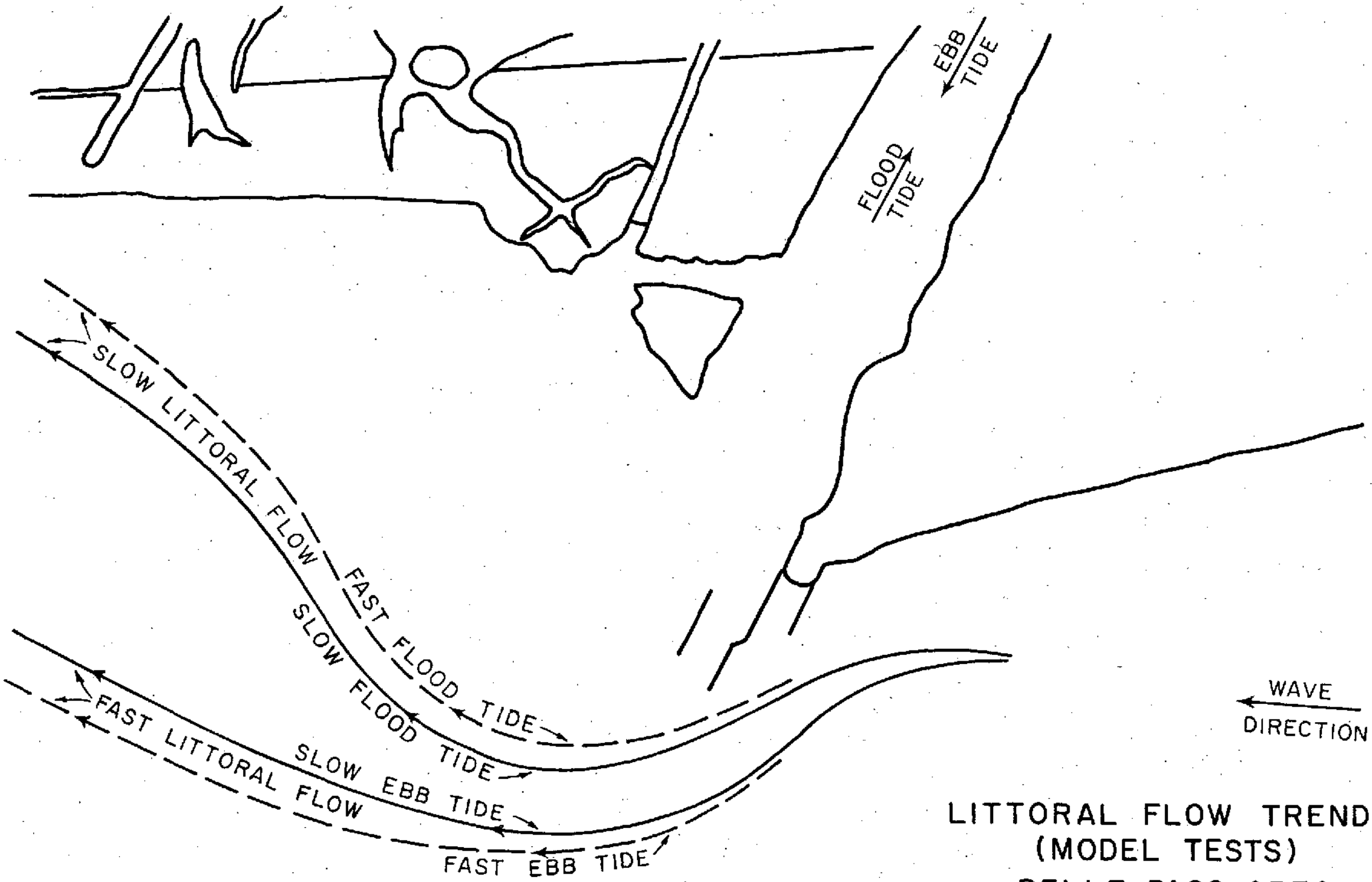
Tests were also run with the existing jetties to simulate flow trends with the wave approach velocity and the tidal flow in the channel being varied. The results of these tests are shown in Figure 21. Similar tests, made with the proposed jetties installed on the model, showed the same trends except for a gulfward shift to accommodate the longer jetty system.


HYDRAULIC MODEL
BELLE PASS AREA
(EXISTING CONDITIONS)
FIG. 19



HYDRAULIC MODEL
BELLE PASS AREA
(WITH PROPOSED JETTY MODIFICATIONS)

FIG. 20



LITTORAL FLOW TRENDS
(MODEL TESTS)
BELLE PASS AREA

FIG. 21

V. CONCLUSIONS AND RECOMMENDATIONS

Comparisons of maps and aerial photographs from 1935 to September 1973 have shown that the existing jetty at Belle Pass has not adversely affected the coastline in the area. Before the construction of the original jetties, the shoreline recession had been estimated by several investigators, who used very old coastal charts, to be between 95 and 150 feet per year.

The Belle Pass area is part of a remnant deltaic plain that has undergone erosion and subsidence during the past 600 or 700 years. At an undefined point east of the jetty, the longshore current, caused by generally southeast waves, changes direction, with flow from east to west toward the jetty and the Timbalier Islands and from west to east toward Grand Isle. Thus the coastline between Belle Pass and Bay Champagne during most of the year is an unreplenished feeder for beach materials in both directions.

The existing jetty and its companion groin apparently have greatly retarded erosion in the area immediately to the east. Between 1945 and 1973, the point of land at the east jetty receded 11 feet (average) per year. Farther east (1000 feet), the recession amounted to 24 feet annually.

West of Belle Pass, the rate was higher. The remnant island receded at a varying rate (38 to 52 feet per year). Farther west, the recession rate apparently becomes evened out to 46 feet per year.

If these average rates for the last 28 years are unquestioned, then it can safely be assumed that the present jetty system has played a major role in the reduced rate of recession at Belle Pass.

Aerial photo interpretation and field observations showed that most eastward-flowing littoral material bypasses the jetty and becomes redeposited west of the pass. (One reason for the bypassing may be the inefficient orientation of the jetty with the east shoreline.) At ebb tide, the materials mix with suspended sediment from Bayou Lafourche. The deposition area varies from 5000 to 8000 feet to the west, depending on ebb or flood tide flow in the channel, and the strength of the littoral current.

Tests on a scale model of the Belle Pass area, with the proposed jetty system in place, indicated that the same bypass conditions would occur. The littoral materials, although deflected farther out by the extended jetty, would be redeposited to the west in the same area as they are now. There is a slight possibility that the proposed east jetty could accumulate some littoral material, even though the orientation with respect to the shoreline is inefficient for the purpose.

Shoreline erosion west of Belle Pass will continue at the present rate from natural processes. The 1200-ft. dike extension on the proposed west jetty will retard wave action on the remnant island and at the mouth of the north-south canal to the west.

A shoreward extension of the existing east jetty and its companion groin should be included, either as part of the proposed construction or as a separate project. A possible breach of the narrow point, especially during storm waves, would result in serious shoaling of the pass.

The study further indicates that the proposed jetty system will offer a much needed safety factor to navigation in and out of Belle Pass at times of rough seas.

VI. REFERENCES

Bruun, Per, 1966, Tidal Inlets and Littoral Drift, H. Skipnes Offsettrykker, Trondheim, Norway.

Coleman, James P. and Gagliano, Sherwood M., 1964, Cyclic Sedimentation in the Mississippi River Deltaic Plain, 1974, Trans. Gulf Coast Assoc. of Geol. Soc., XIV, Corpus Christi.

Kwan, Hyuck J., 1969, Barrier Islands of the Northern Gulf of Mexico Coast: Sediment Source and Development, Coastal Studies Institute Tech. Report No. 75, LSU, Baton Rouge, pp. 26-32.

Louisiana Department of Public Works, 1960, Biennial Report, 1950-1958, Baton Rouge, pp. 191-192.

Morgan, James P., and Larimore, Philip B., 1957, Changes in the Louisiana Shoreline, Transactions of the Gulf Coast Association of Geological Societies, Vol. VII.

Morgan, James P., 1972, Impact of Subsidence and Erosion on Louisiana Coastal Marshes and Estuaries, Proc. of the Second Symposium on Coastal Marsh and Estuary Management, July 17-18, 1972, LSU, Baton Rouge, pp. 217-233.

Peyronnin, Chester A., Jr., 1962, Erosion of Isles Dernieres and Timbalier Islands, Proc. ASCE, Journal of the Waterways and Harbors Div., Paper No. 3048, Feb. 1962

Shore Protection, Planning and Design, 1966, Army Coastal Engineering Research Center, Washington, (Report Number AD 750 451).

Terich, Thomas, and Komar, Paul D., 1973, The Development and Destruction of Bayocean Spit, Oregon, Proc. 3rd Annual Technical Conferences - Estuaries of the Pacific Northwest, March 15-16, 1973.

Whitehurst, C.A., 1974, A Parametric Study of Water Resources Variables in Delta Region of South Louisiana -- Bayou Lafourche, Technical Report to the Office of Water Resources Research, Division of Engineering Research, LSU, February, 1974.

Whitehurst, Charles A., and Self, R.P., 1974, Sediment Transport and Erosion in the Fourchon Area of Lafourche Parish, Division of Engineering Research Monograph No. RM-3, LSU, Baton Rouge, May 1974.